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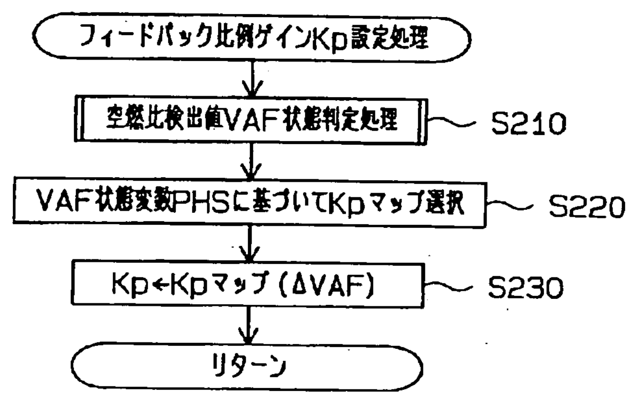
(54)【発明の名称】内燃機関の空燃比制御装置

(57)【要約】

【課題】リニア空燃比センサを用いた内燃機関の空燃比制御装置において、空燃比の状況変化に対応した高精度な空燃比制御を行うことにより、フィードバック周期の増大や空燃比の荒れを防止する。

【解決手段】フィードバック補正係数ＦＡＦの算出に用いられているフィードバック比例ゲインＫｐは、空燃比検出値ＶＡＦの状態（Ｓ２１０）に対応して、複数から選択したフィードバック比例ゲインＫｐマップ（Ｓ２２０）を用いて空燃比偏差ΔＶＡＦにより算出（Ｓ２３０）したものである。このため空燃比検出値ＶＡＦに現れている空燃比の将来の挙動を予め考慮したフィードバック比例ゲインＫｐを設定することが可能となる。したがって今後の状況の変化に対応するフィードバック補正係数ＦＡＦを設定して、高精度な空燃比制御を行うことが可能となり、フィードバック周期の増大や空燃比の荒れを防止することができる。



い、該リニア空燃比センサの検出値における目標空燃比からの偏差に基づいてフィードバック補正量を算出し該フィードバック補正量に基づいて内燃機関の燃焼室に供給される混合気の空燃比を目標空燃比にフィードバック制御する内燃機関の空燃比制御装置であって、前記リニア空燃比センサの検出値に応じて、前記フィードバック補正量を算出するためのフィードバックゲインを設定するフィードバックゲイン設定手段を備えたことを特徴とする。

【０００８】このように、フィードバックゲイン設定手段は、リニア空燃比センサの検出値に応じて、前記フィードバック補正量を算出するためのフィードバックゲインを設定している。このため、リニア空燃比センサの検出値に現れている空燃比の将来の挙動を予め考慮したフィードバックゲインを設定することが可能となる。

【０００９】したがって、今後の状況の変化に対応するフィードバック補正量を設定して、高精度な空燃比制御を行うことが可能となり、フィードバック周期の増大や空燃比の荒れを防止することができる。

【００１０】請求項２記載の内燃機関の空燃比制御装置は、請求項１記載の構成において、前記フィードバックゲイン設定手段は、前記フィードバック補正量の内、比例項を求めるためのフィードバック比例ゲインを、前記リニア空燃比センサの検出値に応じて設定することを特徴とする。

【００１１】このように、フィードバック補正量の内、比例項を求めるためのフィードバック比例ゲインを、空燃比の将来の挙動に対応させることにより、今後の状況の変化に対して、高応答に対処できるようになる。

【００１２】したがって、高精度な空燃比制御を行うことが可能となり、フィードバック周期の増大や空燃比の荒れを防止することができる。請求項３記載の内燃機関の空燃比制御装置は、請求項１記載の構成において、前記フィードバックゲイン設定手段は、前記フィードバック補正量の内、比例項を求めるためのフィードバック比例ゲインと、積分項を求めるためのフィードバック積分ゲインとを、前記リニア空燃比センサの検出値に応じて設定することを特徴とする。

【００１３】このように、フィードバック補正量の内、比例項を求めるためのフィードバック比例ゲインと積分項を求めるためのフィードバック積分ゲインとの両者を、空燃比の将来の挙動に対応させることにより、今後の状況の変化に対して、より高応答に対処できるようになる。

【００１４】したがって、より高精度な空燃比制御を行うことが可能となり、フィードバック周期の増大や空燃比の荒れを防止することができる。請求項４記載の内燃機関の空燃比制御装置は、請求項１～３のいずれか記載の構成において、前記フィードバックゲイン設定手段は、前記リニア空燃比センサの検出値の状態に応じて、前記フィードバックゲインを設定するパターンを切り替えることを特徴とする。

【００１５】ここで、フィードバックゲイン設定手段は、リニア空燃比センサの検出値に応じて、フィードバック補正量を算出するためのフィードバックゲインを設定しているのみでなく、リニア空燃比センサの検出値の状態に応じて、フィードバック補正量を算出するためのフィードバックゲインを設定するパターンを切り替えている。

【００１６】このことにより、より的確に、空燃比の将来の挙動に対応させることが可能となり、今後の状況の変化に対して更に高応答に対処できるようになる。したがって、更に高精度な空燃比制御を行うことが可能となり、フィードバック周期の増大や空燃比の荒れを防止することができる。

【００１７】請求項５記載の内燃機関の空燃比制御装置は、請求項４記載の構成において、前記フィードバックゲイン設定手段は、前記リニア空燃比センサの検出値を、目標空燃比に近づく状態と、目標空燃比から離れる状態とに分類し、該状態毎に、前記フィードバックゲインを設定するパターンを切り替えることを特徴とする。

【００１８】より具体的には、リニア空燃比センサの検出値の変化状態として、目標空燃比に近づく状態と、目標空燃比から離れる状態とに分類することができ、これらの状態毎に、フィードバック補正量を算出するためのフィードバックゲインを設定するパターンを切り替えることができる。

【００１９】このようにフィードバックゲインを設定するパターンを切り替えることにより、より的確に、空燃比の将来の挙動に対応させることが可能となり、今後の状況の変化に対して更に高応答に対処できるようになる。

【００２０】したがって、更に高精度な空燃比制御を行うことが可能となり、フィードバック周期の増大や空燃比の荒れを防止することができる。請求項６記載の内燃機関の空燃比制御装置は、請求項４記載の構成において、前記フィードバックゲイン設定手段は、前記リニア空燃比センサの検出値を、目標空燃比より燃料濃度が濃いリッチ状態と、目標空燃比より燃料濃度が薄いリーン状態とに分類し、該状態毎に、前記フィードバックゲインを設定するパターンを切り替えることを特徴とする。

【００２１】より具体的には、リニア空燃比センサの検出値の状態として、目標空燃比より燃料濃度が濃いリッチ状態と、目標空燃比より燃料濃度が薄いリーン状態とに分類することができ、これらの状態毎に、フィードバック補正量を算出するためのフィードバックゲインを設定するパターンを切り替えることができる。

【００２２】このようにフィードバックゲインを設定するパターンを切り替えることにより、より的確に、空燃比の将来の挙動に対応させることが可能となり、今後の

すごとくの電圧で表される空燃比検出値ＶＡＦに変換された後に、この空燃比検出値ＶＡＦに基づいて後述するごとく空燃比フィードバック制御がなされ、燃料噴射量の増減処理により、空燃比が目標空燃比に調整される。

【００３６】なお、回転数センサ９０は、エンジン４のクランク軸（図示略）の回転に基づいてエンジン４の回転数ＮＥに応じた頻度のパルス信号を出力し、気筒判別センサ９２は気筒８～１４を判別するためにクランク軸の回転に基づいて所定のクランク角度毎に基準信号となるパルス信号を出力する。ＥＣＵ５０はこれら回転数センサ９０および気筒判別センサ９２からの出力信号に基づいて回転数ＮＥおよびクランク角度の算出、更に気筒判別を行う。

【００３７】また、シリンダブロック６にはエンジン冷却水温を検出するための水温センサ９４が設けられて、冷却水温ＴＨＷに応じた信号を出力する。次に本実施の形態１における空燃比制御装置の機能を果たしている制御系統の電気的構成について図４のブロック図を参照して説明する。

【００３８】ＥＣＵ５０は、中央処理装置（ＣＰＵ）５０ａ、読み出し専用メモリ（ＲＯＭ）５０ｂ、ランダムアクセスメモリ（ＲＡＭ）５０ｃ、およびバックアップＲＡＭ５０ｄ等を備え、これら各部５０ａ～５０ｄと、入力回路５０ｅおよび出力回路５０ｆ等とを双方向バス５０ｇにより接続してなる論理演算回路として構成されている。ＲＯＭ５０ｂには後述する空燃比フィードバック制御を実現する各種制御プログラムや各種データが予め記憶されている。ＲＡＭ５０ｃには各種制御処理におけるＣＰＵ５０ａの演算結果等が一時的に記憶される。

【００３９】また、入力回路５０ｅはバッファ、波形整形回路およびＡ／Ｄ変換器等を含んだ入力インターフェースとして構成されており、前記スロットルセンサ３６、アクセル開度センサ４０、吸気圧センサ６８、リニア空燃比センサ８０、回転数センサ９０、気筒判別センサ９２、水温センサ９４、各イグニッションコイル７０ａ～７６ａの点火確認信号ＩＧｆのライン等がそれぞれ接続されている。各種センサ３６，４０，６８，８０，９０，９２，９４等の出力信号はデジタル信号に変換されて入力回路５０ｅから双方向バス５０ｇを介してＣＰＵ５０ａ等に読み込まれる。

【００４０】一方、出力回路５０ｆは各種駆動回路等を有しており、前記インジェクタ２４～３０、イグニッションコイル７０ａ～７６ａ、スロットルモータ３４等がそれぞれ接続されている。ＥＣＵ５０は各種センサ３６，４０，６８，８０，９０，９２，９４等からの出力＊＊信号に基づいて演算処理を行い、インジェクタ２４～３０、イグニッションコイル７０ａ～７６ａ、スロットルモータ３４等を駆動制御する。

【００４１】例えば、ＥＣＵ５０は吸気圧センサ６８により検出される吸気圧ＰＭ、回転数センサ９０により検出される回転数ＮＥ等に基づいてエンジン４の負荷を算出するとともに、その負荷の大きさに応じて、インジェクタ２４～３０による燃料噴射量や燃料噴射時期、あるいはイグニッションコイル７０ａ～７６ａによる点火時期を制御している。そしてリニア空燃比センサ８０により検出される空燃比に基づいて、後述するごとく、インジェクタ２４～３０による燃料噴射量の増減補正を実行して、混合気の空燃比を目標空燃比に精密に制御している。

【００４２】次に、本実施の形態１においてＥＣＵ５０により実行される空燃比フィードバック制御について図５以下のフローチャートに基づいて説明する。なお各処理に対応するフローチャート中のステップを「Ｓ～」で表す。

【００４３】図５のフローチャートにフィードバック補正係数ＦＡＦ算出処理を示す。本処理は一定のクランク角毎に繰り返し実行される処理である。本フィードバック補正係数ＦＡＦ算出処理が開始されると、まず、アクセル開度センサ４０の信号から得られているアクセル開度ＡＣＣＰ、回転数センサ９０の信号から得られているエンジン回転数ＮＥおよびリニア空燃比センサ８０の信号から得られている空燃比検出値ＶＡＦをＲＡＭ５０ｃの作業領域に読み込む（Ｓ１１０）。

【００４４】次に、目標空燃比ＶＡＦｔが設定される（Ｓ１２０）。ここで、エンジン４が空燃比フィードバック制御時に理論空燃比のみに制御するタイプでは、目標空燃比ＶＡＦｔには理論空燃比に相当する値が設定されるが、エンジン４がリーンバーンエンジンなどで、理論空燃比以外に、理論空燃比よりも燃料濃度が希薄な空燃比（以下、「リーン空燃比」と称する）での燃焼方式を実行する場合には、エンジン４の運転状態、例えばアクセル開度ＡＣＣＰとエンジン回転数ＮＥとに基づいてマップから、理論空燃比～リーン空燃比までの間で、適切な目標空燃比ＶＡＦｔが設定される。ここでは、エンジン４はリーンバーンエンジンとする。

【００４５】次に、次式１に示すごとく、空燃比検出値ＶＡＦにおける目標空燃比ＶＡＦｔからの偏差を表す空燃比偏差ΔＶＡＦを求める（Ｓ１３０）。

【００４６】

【数１】

$$\Delta VAF \leftarrow VAF - VAFt \quad \cdots \quad [式1]$$

次に、フィードバック比例ゲインＫｐ設定処理を実行する（Ｓ１４０）。このフィードバック比例ゲインＫｐ設定処理の詳細を図６のフローチャートに示す。本フィードバック比例ゲインＫｐ設定処理では、まず、空燃比検出値ＶＡＦ状態判定処理が行われる（Ｓ２１０）。この空燃比検出値ＶＡＦ状態判定処理の詳細を図７および図８のフローチャートに示す。

【００４７】本空燃比検出値ＶＡＦ状態判定処理では、

に示すごとく、フィードバック補正係数ＦＡＦ（フィードバック補正量に相当する）が算出される（Ｓ１５０）。

【００６２】
【数６】

$$FAF \leftarrow Kp \times \Delta VAF + KI \times \Sigma(\Delta VAF) + 1.0 \quad \cdots \text{[式6]}$$

ここで、「Ｋｐ×ΔＶＡＦ」はフィードバック制御の比例項、「ＫＩ×Σ（ΔＶＡＦ）」は、フィードバック制御の積分項を表し、「Σ（ΔＶＡＦ）」が空燃比偏差ΔＶＡＦの積分値、ＫＩがフィードバック積分ゲインを表している。なお、このフィードバック積分ゲインＫＩは、本実施の形態１では空燃比偏差ΔＶＡＦに依存せず、一定値が用いられている。

【００６３】こうして、フィードバック補正係数ＦＡＦ算出処理を一旦終了する。このようにして求められたフィードバック補正係数ＦＡＦは、図１４のフローチャートに示す燃料噴射処理において用いられる。本燃料噴射処理は、一定クランク角毎に繰り返し実行される。

【００６４】燃料噴射処理が開始されると、まず、エンジン回転数ＮＥおよび吸気圧ＰＭに基づいて、ＲＯＭ５０ｂに記憶されているマップＭＴＰから基本燃料噴射弁開弁時間ＴＰを求める（Ｓ５１０）。

【００６５】次に、この基本燃料噴射弁開弁時間ＴＰおよびフィードバック補正係数ＦＡＦ算出処理（図５）で算出されたフィードバック補正係数ＦＡＦ等の値に基づいて燃料噴射弁開弁時間ＴＡＵを次式７により演算する（Ｓ５２０）。

【００６６】
【数７】

$$TAU \leftarrow K3 \cdot TP \cdot \{FAF + KG(m)\} + K4 \quad \cdots \text{[式7]}$$

ここで、ＫＧ（ｍ）は、「１．０」からのフィードバック補正係数ＦＡＦの偏差の状態を学習処理により得た学習値である。またＫ３およびＫ４は他の補正係数である。

【００６７】次に、燃料噴射弁開弁時間ＴＡＵを出力して（Ｓ５３０）、燃料噴射処理を一旦終了する。上述した構成において行われる制御の一例を図１５に示す。図１５において、（Ａ）の実線は空燃比検出値ＶＡＦを表している。（Ｂ）はフィードバック補正係数ＦＡＦの状態を表している。本図からも判るように、フィードバック補正係数ＦＡＦの変化パターンは、空燃比検出値ＶＡＦの変化パターンよりも、時間的に前にずれており、将来の空燃比変化を考慮したものとなっている。

【００６８】上述した実施の形態１の構成において、フィードバック補正係数ＦＡＦ算出処理（図５）、フィードバック比例ゲインＫｐ設定処理（図６）および空燃比検出値ＶＡＦ状態判定処理（図７，図８）が、フィードバックゲイン設定手段に相当する。

【００６９】以上説明した本実施の形態１によれば、以下の効果が得られる。（イ）．ステップＳ１５０にてフィードバック補正係数ＦＡＦの算出に用いられているフィードバック比例ゲインＫｐは、ステップＳ２３０において、図１０～図１３に示したフィードバック比例ゲインＫｐマップのいずれかから空燃比偏差ΔＶＡＦに基づいて算出したものである。

【００７０】この空燃比偏差ΔＶＡＦは空燃比検出値ＶＡＦにおける目標空燃比ＶＡＦｔからの偏差を表していることから、空燃比検出値ＶＡＦに応じて、フィードバック補正係数ＦＡＦを算出するためのフィードバック比例ゲインＫｐを設定していることになり、リニア空燃比センサ８０の空燃比検出値ＶＡＦに現れている空燃比の将来の挙動を予め考慮したフィードバック比例ゲインＫｐを設定することが可能となる。

【００７１】したがって、図１０～図１３に示したごとく今後の状況の変化に対応するフィードバック補正係数ＦＡＦを設定して、高精度な空燃比制御を行うことが可能となり、フィードバック周期の増大や空燃比の荒れを防止することができる。

【００７２】なお、フィードバック補正係数ＦＡＦの内でも、特に比例項を求めるためのフィードバック比例ゲインＫｐを設定している。比例項は積分項に比較して空燃比検出値ＶＡＦの変動に迅速に対処できる。このことにより、フィードバック補正係数ＦＡＦの内でも、比例項を求めるためのフィードバック比例ゲインＫｐを、空燃比検出値ＶＡＦに対応させることにより、今後の状況の変化に対して、より高応答に対処できるようになる。

【００７３】（ロ）．空燃比検出値ＶＡＦに対するフィードバック比例ゲインＫｐのパターンは、空燃比検出値ＶＡＦの状態に応じて切り替えられている。具体的には、空燃比検出値ＶＡＦが目標空燃比ＶＡＦｔからリッチ状態へ離れる「状態１」と、リッチ状態から目標空燃比ＶＡＦｔに近づく「状態２」と、目標空燃比ＶＡＦｔからリーン状態へ離れる「状態３」と、リーン状態から目標空燃比ＶＡＦｔに近づく「状態４」とに分類されている。そして、図１０～図１３に示すごとく、これらの状態毎に、フィードバック補正係数ＦＡＦを算出するためのフィードバック比例ゲインＫｐを設定するパターンを切り替えている。

【００７４】ここで、空燃比検出値ＶＡＦが目標空燃比ＶＡＦｔからリッチ状態へ離れる状態１では図１０に示したごとく、負の値である空燃比偏差ΔＶＡＦが「０」に近い位置から既に大きいフィードバック比例ゲインＫ

を、より高応答に設定することが可能となる。したがって、より高精度な空燃比制御を行うことが可能となり、フィードバック周期の増大や空燃比の荒れを防止できる。

【００８６】［実施の形態３］本実施の形態３では、前記実施の形態１におけるフィードバック補正係数ＦＡＦ算出処理（図５）および空燃比検出値ＶＡＦ状態判定処理（図７，８）の代わりに、図１９に示すフィードバック補正係数ＦＡＦ算出処理および図２０，２１に示す空燃比検出値ＶＡＦ状態判定処理を実行する。フィードバック比例ゲインＫｐ設定処理（図６）および他の構成に＊

＊ついては、前記実施の形態１と同じである。

【００８７】図１９の処理においては、ステップＳ７４５を除いて、ステップＳ７１０，Ｓ７２０，Ｓ７４０，Ｓ７５０は、それぞれ図５のステップＳ１１０，Ｓ１２０，Ｓ１４０，Ｓ１５０の処理と同じである。なお、図５のステップＳ１３０に対応する処理としてステップＳ７４５がステップＳ７４０の次に実行される。

【００８８】ステップＳ７４５は、次式８により空燃比偏差ΔＶＡＦを求める。

【００８９】

【数８】

$$\Delta VAF \leftarrow VAF - VAFJ \quad \cdots \quad [\text{式}8]$$

空燃比判定値ＶＡＦＪは後述する空燃比検出値ＶＡＦ状態判定処理にて設定される値である。

【００９０】図２０，２１の処理においては、ステップＳ８１０，Ｓ８５０，Ｓ８７５，Ｓ９１０，Ｓ９３５を除いて、図７，８の処理に付されたステップ番号に４００を加えたステップ番号の処理が対応している。

【００９１】図２０，２１の処理の内、ステップＳ８１０では、空燃比検出値ＶＡＦが空燃比判定値ＶＡＦＪよりリーン側かリッチ側かを判定している。また、ＶＡＦ※

※≦ＶＡＦＪ（Ｓ８１０で「ＹＥＳ」）である場合に実行されるステップＳ８５０では、リーンピーク判定値ＶＡＦＬに空燃比判定値ＶＡＦＪを設定している。更に、ＶＡＦ＞ＶＡＦＲ（Ｓ８２０で「ＮＯ」）の場合に実行されるステップＳ８７５では、次式９に示すごとく空燃比判定値ＶＡＦＪを設定している。

【００９２】

【数９】

$$VAFJ \leftarrow VAFt - dV \quad \cdots \quad [\text{式}9]$$

ここで、オフセット値ｄＶは、空燃比判定値ＶＡＦＪを目標空燃比ＶＡＦｔよりも小さく設定するための値である。

【００９３】また、ＶＡＦ＞ＶＡＦＪ（Ｓ８１０で「ＮＯ」）である場合に実行されるステップＳ９１０では、リッチピーク判定値ＶＡＦＲに空燃比判定値ＶＡＦＪを★

★設定している。更に、ＶＡＦ≦ＶＡＦＬ（Ｓ８８０で「ＮＯ」）の場合に実行されるステップＳ９３５では、次式１０に示すごとく空燃比判定値ＶＡＦＪを設定している。

【００９４】

【数１０】

$$VAFJ \leftarrow VAFt + dV \quad \cdots \quad [\text{式}10]$$

ここで、オフセット値ｄＶは、空燃比判定値ＶＡＦＪを目標空燃比ＶＡＦｔよりも大きくするための値である。

【００９５】本実施の形態３はこのように構成されているため、リーン状態およびリッチ状態を判定するためのレベル（空燃比判定値ＶＡＦＪ）が、空燃比制御の反転が早くなるように切り替えられる。このため、図２２のタイミングチャートに示すごとく、「状態２」または「状態４」の期間が短くなり、早期に「状態３」または「状態１」に移行するようになる。したがって、全体としてもフィードバック周期が短くなる。

【００９６】上述した実施の形態３の構成において、フィードバック補正係数ＦＡＦ算出処理（図１９）、フィードバック比例ゲインＫｐ設定処理（図６）および空燃比検出値ＶＡＦ状態判定処理（図２０，図２１）が、フィードバックゲイン設定手段に相当する。

【００９７】以上説明した本実施の形態３によれば、以下の効果が得られる。

（イ）．前記実施の形態１の（イ）および（ロ）の効果が生じる。

（ロ）．空燃比検出値ＶＡＦがリーン側かリッチ側かを判定する空燃比判定値ＶＡＦＪは、目標空燃比ＶＡＦｔを用いて早期にリーン側とリッチ側との間の判定が切り替わるように設定されているため、図２２に示したごとくフィードバック周期が更に短くなる。このため、より高精度な空燃比制御を行うことが可能となる。

【００９８】［その他の実施の形態］

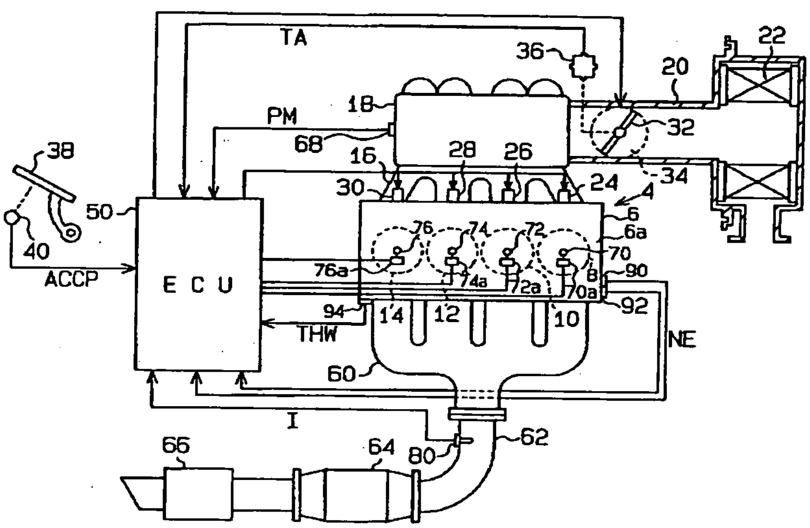
・前記各実施の形態においては、噴射燃料量を調整することにより空燃比制御を実行する装置であったが、これ以外に、スロットルバルブ３２の開度に対するフィードバック調整により空燃比を制御するタイプの装置でも良い。この場合は、フィードバック比例ゲインＫｐおよびフィードバック積分ゲインＫＩは、スロットル開度ＴＡに対するフィードバック制御におけるフィードバック補正係数を計算するために用いられる。

【００９９】・前記各実施の形態において、空燃比検出値ＶＡＦの状態を、「状態１～４」の状態に分類したが、これ以外に、目標空燃比ＶＡＦｔあるいは空燃比判定値ＶＡＦＪよりもリーン側かリッチ側かで２つに分類しても良いし、目標空燃比ＶＡＦｔあるいは空燃比判定値ＶＡＦＪに近づく方向か離れる方向かにより２つに分類しても良い。

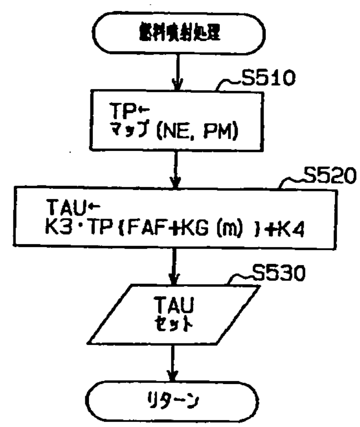
【０１００】・前記各実施の形態において用いられた

ヘッド、８，１０，１２，１４…気筒、１６…インテークマニホールド、１８…サージタンク、２０…吸気通路、２２…エアクリーナ、２４，２６，２８，３０…インジェクタ、３２…スロットルバルブ、３４…スロットルモータ、３６…スロットルセンサ、３８…アクセルペダル、４０…アクセル開度センサ、５０…ＥＣＵ、５０ａ…ＣＰＵ、５０ｂ…ＲＯＭ、５０ｃ…ＲＡＭ、５０ｄ…バックアップＲＡＭ、５０ｅ…入力回路、５０ｆ…出力回路、５０ｇ…双方向バス、６０…エグゾーストマニホールド、６２…排気通路、６４…触媒コンバータ、６６…マフラ、６８…吸気圧センサ、７０，７２，７４，７６…点火プラグ、７０ａ，７２ａ，７４ａ，７６ａ…イグニッションコイル、８０…リニア空燃比センサ、９０…回転数センサ、９２…気筒判別センサ、９４… 水温センサ。

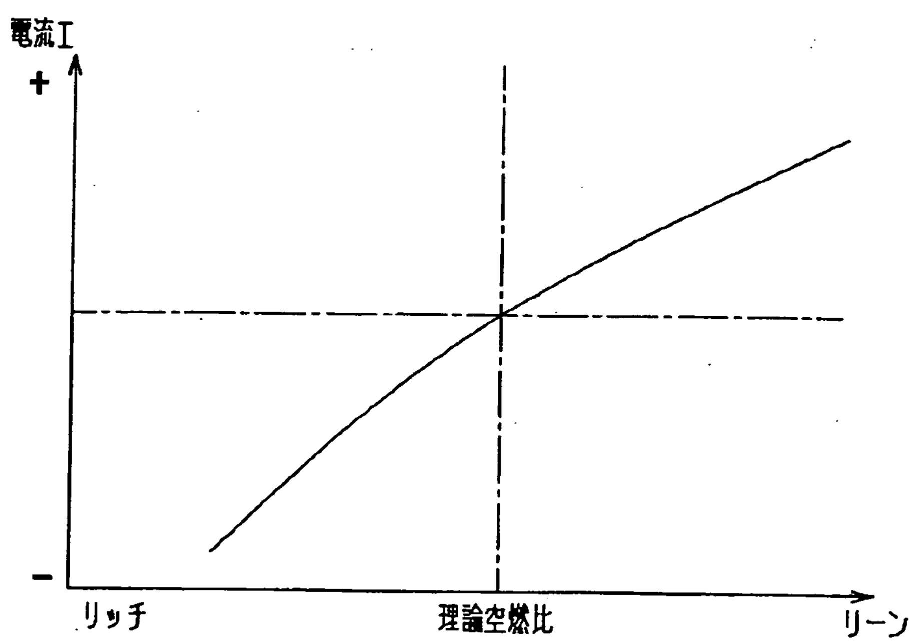
【図１】



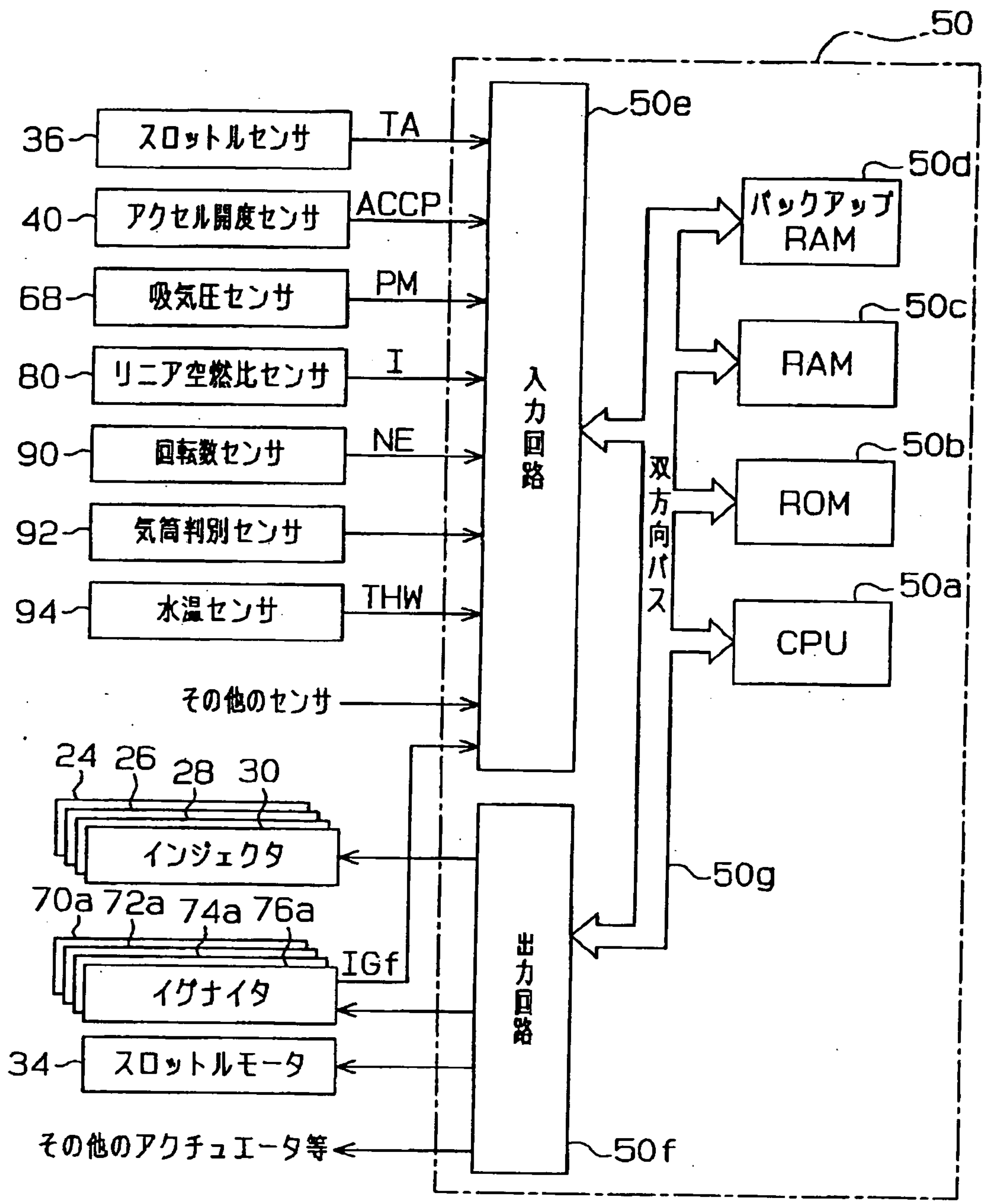
【図１４】



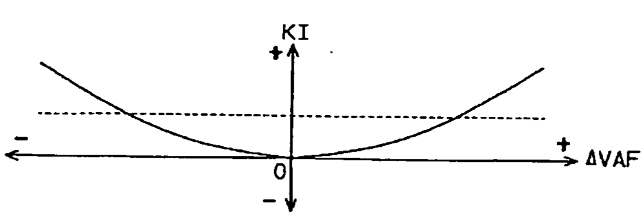
【図２】



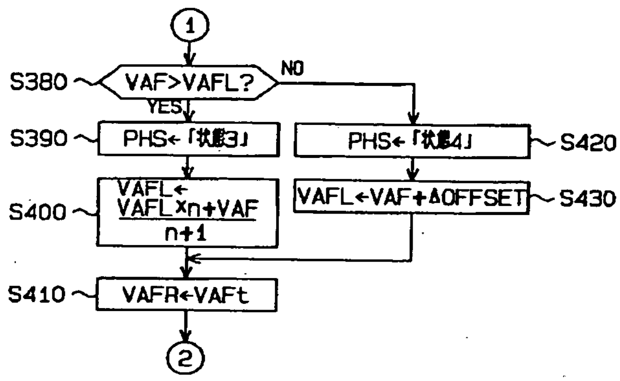
【図４】


50
50e
36
スロットルセンサ
TA
40
アクセル開度センサ
ACCP
68
吸気圧センサ
PM
80
リニア空燃比センサ
I
90
回転数センサ
NE
92
気筒判別センサ
94
水温センサ
THW
その他のセンサ
入力回路
双方向バス
50d
バックアップRAM
50c
RAM
50b
ROM
50a
CPU
24 26 28 30
インジェクタ
70a 72a 74a 76a
IGf
イグナイタ
34
スロットルモータ
その他のアクチュエータ等
出力回路
50g
50f

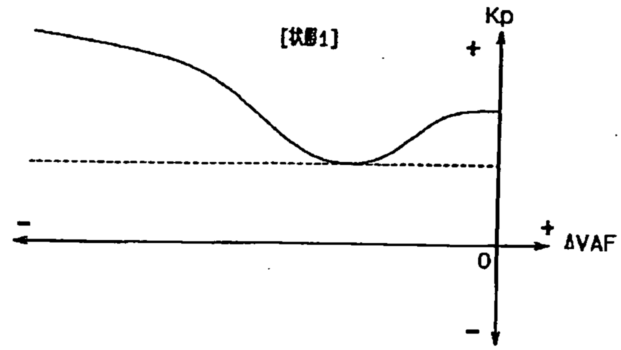
【図１７】


KI
+
−
+
ΔVAF
0
−

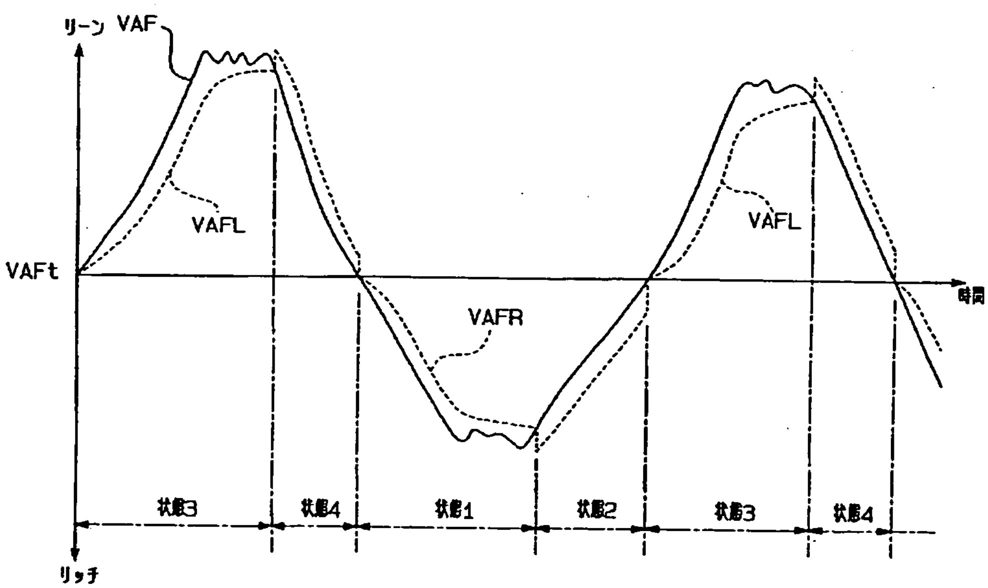
【図８】



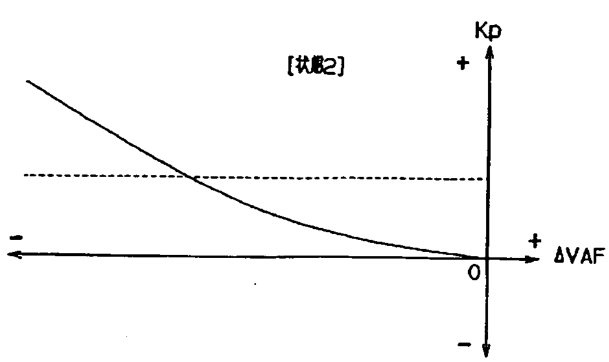
【図１０】



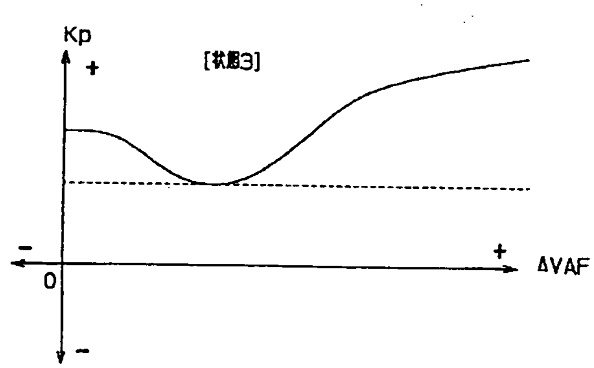
【図９】



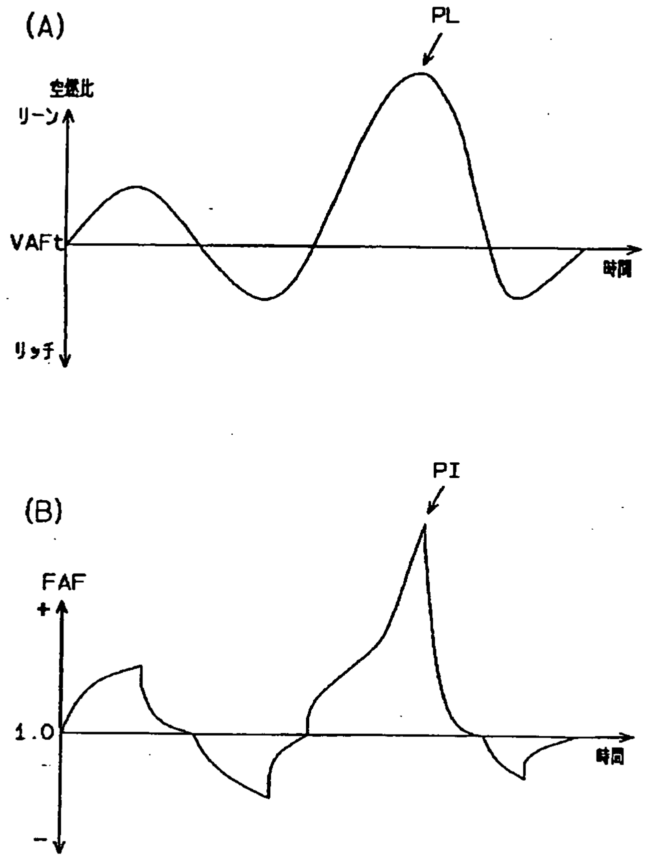
【図１１】



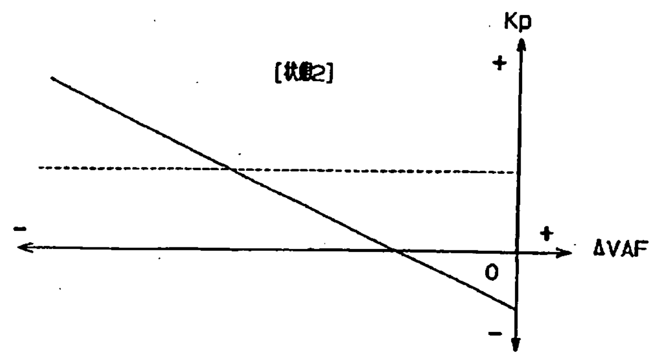
【図１２】



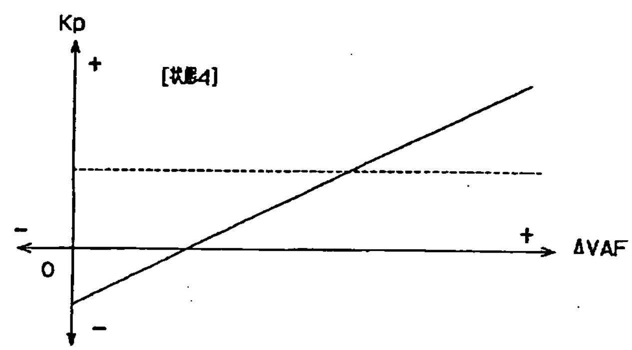
【図１８】



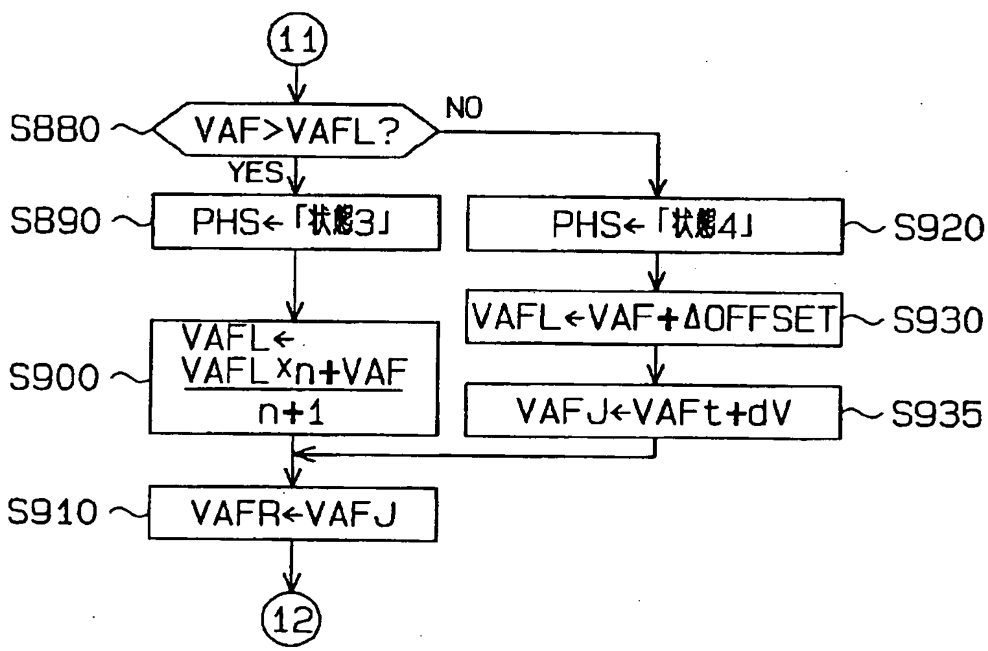
【図２３】



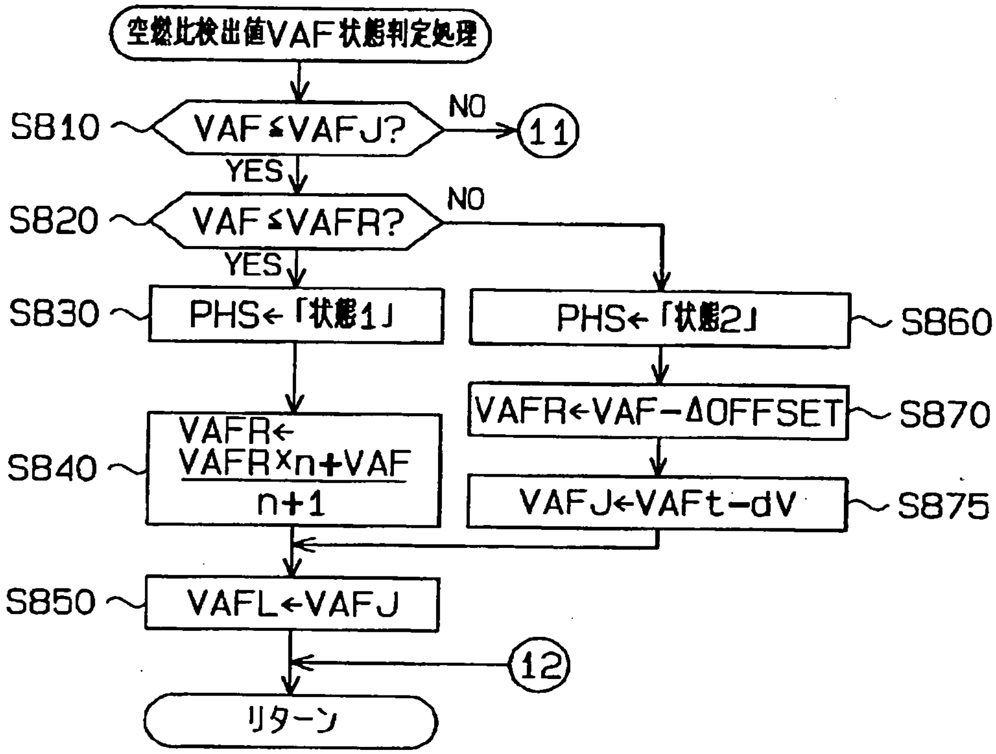
【図２４】



【図２１】



【図２０】



空燃比検出値VAF状態判定処理
S810
VAF≦VAFJ?
NO
11
YES
S820
VAF≦VAFR?
NO
YES
S830
PHS←「状態1」
S860
PHS←「状態2」
S840
VAFR←
VAFR×n+VAF
n+1
S870
VAFR←VAF−ΔOFFSET
S875
VAFJ←VAFt−dV
S850
VAFL←VAFJ
12
リターン

フロントページの続き

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DA25 EA11 EB08 EB12 EB15
EB17 EB25 EC03 FA10 FA11
FA18 FA20 FA29 FA33 FA35
FA38 FA39
3G301 HA15 JA04 JA06 JA21 LA03
LC03 MA01 MA11 MA18 NA01
NA03 NA04 NA08 NB02 NC02
ND02 ND05 ND21 NE15 PA07Z
PA11Z PA17Z PD04A PE01Z
PE04Z PE05Z PE08Z PE09Z
PF03Z

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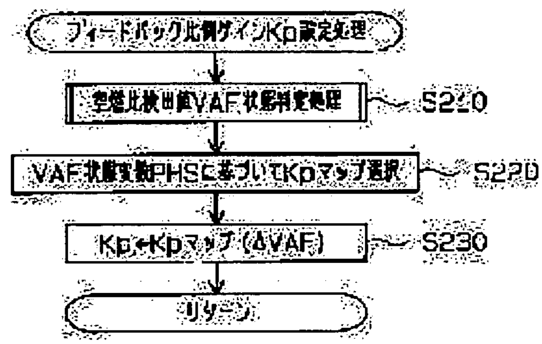
(71)Applicant : TOYOTA MOTOR CORP
(72)Inventor : MITSUYA NORITAKE

(54) AIR-FUEL RATIO CONTROL DEVICE OF INTERNAL COMBUSTION ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent an increase in a feedback period and roughness of the air-fuel ratio by performing highly accurate air-fuel ratio control corresponding to a state change of the air-fuel ratio in an air-fuel ratio control device of an internal combustion engine using a linear air-fuel ratio sensor.
SOLUTION: Feedback proportional gain Kp used to calculate a feedback correction factor FAF is calculated by an air-fuel ratio deviation ΔVAF by using a feedback proportional gain KP map (S220) selected from a plurality in response to a state (S210) of an air-fuel ratio detecting value VAF (S230). Thus, the feedback proportional gain Kp by taking in preconsideration future behavior of the air-fuel ratio appearing in the air-fuel ratio detecting value VAF can be set. Thus, the feedback correction factor FAF corresponding to a future state change is set, and the highly accurate air-fuel ratio control can be performed, and the increase in the feedback period and the roughness of the air-fuel ratio can be prevented.



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[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision of rejection]
[Date of requesting appeal against examiner's decision of rejection]

CLAIMS

[Claim(s)]
[Claim 1] The linear air-fuel ratio sensor by which an output is proportional to an internal combustion engine's air-fuel ratio mostly is used. It is the air-fuel ratio control system of the internal combustion engine which does feedback control of the air-fuel ratio of the gaseous mixture which computes the amount of feedback amendments based on the deflection from the target air-fuel ratio in the detection value of this linear air-fuel ratio sensor, and is supplied to an internal combustion engine's combustion chamber based on this amount of feedback amendments to a target air-fuel ratio. The air-fuel ratio control system of the internal combustion engine characterized by having a feedback gain setting-out means to set up the feedback gain for computing said amount of feedback amendments, according to the detection value of said linear air-fuel ratio sensor.
[Claim 2] It is the air-fuel ratio control system of the internal combustion engine characterized by setting up feedback proportional gain for said feedback gain setting-out means asking for a proportional among said amounts of feedback amendments in a configuration according to claim 1 according to the detection value of said linear air-fuel ratio sensor.
[Claim 3] It is the air-fuel ratio control system of the internal combustion engine characterized by setting up feedback proportional gain for said feedback gain setting-out means asking for a proportional among said amounts of feedback amendments in a configuration according to claim 1, and the feedback integral gain for searching for an integral term according to the detection value of said linear air-fuel ratio sensor.
[Claim 4] Claims 1-3 are the air-fuel ratio control systems of the internal combustion engine characterized by changing the pattern with which said feedback gain setting-out means sets up said feedback gain in the configuration of a publication according to the condition of the detection value of said linear air-fuel ratio sensor either.
[Claim 5] It is the air-fuel ratio control system of the internal combustion engine characterized by changing the pattern which classifies into the condition that said feedback gain setting-out means approaches a target air-fuel ratio in the detection value of said linear air-fuel ratio sensor in a configuration according to claim 4, and the condition of separating from a target air-fuel ratio, and sets up said feedback gain for this every condition.
[Claim 6] It is the air-fuel ratio control system of the internal combustion engine characterized by changing the pattern which said feedback gain setting-out means classifies the detection value of said linear air-fuel ratio sensor into the rich condition that fuel concentration is deeper than a target air-fuel ratio, and the Lean condition that fuel concentration is thinner than a target air-fuel ratio, in a configuration according to claim 4, and sets up said feedback gain for this every condition.
[Claim 7] In a configuration according to claim 4 said feedback gain setting-out means The condition of approaching a target air-fuel ratio in the detection value of said linear air-fuel ratio sensor from the rich condition that fuel concentration is deeper than a target air-fuel ratio, The condition of separating from a target air-fuel ratio to a rich condition, and the condition of approaching a target air-fuel ratio from the Lean condition that fuel concentration is thinner than a target air-fuel ratio, The air-fuel ratio control system of the internal combustion engine characterized by changing the pattern which classifies into the condition of separating from a target air-fuel ratio to the Lean condition, and sets up said feedback gain for this every condition.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the air-fuel ratio control system of the internal combustion engine which does feedback control of the air-fuel ratio of the gaseous mixture by which an output computes the amount of feedback amendments based on the deflection from the target air-fuel ratio in the detection value of this linear air-fuel ratio sensor, and is supplied to an internal combustion engine's combustion chamber based on this amount of feedback amendments using the linear air-fuel ratio sensor mostly proportional to an internal combustion engine's air-fuel ratio to a target air-fuel ratio.
[0002]
[Description of the Prior Art] It is used for an internal combustion engine's exhaust air system, and the linear air-fuel ratio sensor which performs the output mostly proportional to the air-fuel ratio which has appeared in the exhaust air component is known. And the air-fuel ratio control system of the internal combustion engine which controls the air-fuel ratio of gaseous mixture by using this linear air-fuel ratio sensor to a target air-fuel ratio, for example, theoretical air fuel ratio, is known (JP,60-101234,A, JP,4-187842,A).
[0003] Since the air-fuel ratio control system using such a linear air-fuel ratio sensor can always measure a actual air-fuel ratio unlike the system which uses the oxygen sensor with which it turns out that the air-fuel ratio crossed theoretical air fuel ratio because an output changes in step near the theoretical air fuel ratio, it can perform Air Fuel Ratio Control to a high response.
[0004]
[Problem(s) to be Solved by the Invention] However, also in the system using a linear air-fuel ratio sensor, the air-fuel ratio which becomes clear by the linear air-fuel ratio sensor is an air-fuel ratio in the event of being exhausted after the gaseous mixture which adjusted the air-fuel ratio burning, and reaching a linear air-fuel ratio sensor. For this reason, excess and deficiency may arise in the amount of feedback amendments before and after target air-fuel ratio attainment especially. In order to prevent such control-precision lowering, with said conventional technique, it corresponds by referring to the past air-fuel ratio detection value.
[0005] However, it is inadequate to have referred to the past air-fuel ratio detection value, in order to correspond to change of a future situation, and prevention of the excess and deficiency of the amount of feedback amendments cannot but become inadequate. Therefore, precision lowering of Air Fuel Ratio Control cannot fully be prevented, but a feedback period increases, or it is ruined, and fear, such as aggravation of emission, arises.
[0006] This invention aims at preventing buildup of a feedback period, and the dry area of an air-fuel ratio in the air-fuel ratio control system of the internal combustion engine which used the linear air-fuel ratio sensor by performing highly precise Air Fuel Ratio Control corresponding to the change of a situation of an air-fuel ratio.
[0007]
[Means for Solving the Problem] Hereafter, the means and its operation effectiveness for attaining the above-mentioned object are indicated. The air-fuel ratio control system of an internal combustion engine according to claim 1 The linear air-fuel ratio sensor by which an output is proportional to an internal combustion engine's air-fuel ratio mostly is used. It is the air-fuel ratio control system of the internal combustion engine which does feedback control of the air-fuel ratio of the gaseous mixture which computes the amount of feedback amendments based on the deflection from the target air-fuel ratio in the detection value of this linear air-fuel ratio sensor, and is supplied to an internal combustion engine's combustion chamber based on this amount of

feedback amendments to a target air-fuel ratio. It is characterized by having a feedback gain setting-out means to set up the feedback gain for computing said amount of feedback amendments, according to the detection value of said linear air-fuel ratio sensor.
[0008] Thus, the feedback gain setting-out means has set up the feedback gain for computing said amount of feedback amendments according to the detection value of a linear air-fuel ratio sensor. For this reason, it becomes possible to set up the feedback gain which took into consideration beforehand the future behavior of the air-fuel ratio which has appeared in the detection value of a linear air-fuel ratio sensor.
[0009] Therefore, the amount of feedback amendments corresponding to change of a future situation is set up, it becomes possible to perform highly precise Air Fuel Ratio Control, and buildup of a feedback period and the dry area of an air-fuel ratio can be prevented.
[0010] The air-fuel ratio control system of an internal combustion engine according to claim 2 is characterized by said feedback gain setting-out means setting up the feedback proportional gain for asking for a proportional among said amounts of feedback amendments according to the detection value of said linear air-fuel ratio sensor in a configuration according to claim 1.
[0011] Thus, a high response can be coped with now to change of a future situation by making the feedback proportional gain for asking for a proportional among the amounts of feedback amendments correspond to the future behavior of an air-fuel ratio.
[0012] Therefore, it becomes possible to perform highly precise Air Fuel Ratio Control, and buildup of a feedback period and the dry area of an air-fuel ratio can be prevented. The air-fuel ratio control system of an internal combustion engine according to claim 3 is characterized by said feedback gain setting-out means setting up the feedback proportional gain for asking for a proportional among said amounts of feedback amendments, and the feedback integral gain for searching for an integral term according to the detection value of said linear air-fuel ratio sensor in a configuration according to claim 1.
[0013] Thus, a high response can be coped with more now to change of a future situation by making both with the feedback integral gain for searching for the feedback proportional gain and the integral term for asking for a proportional among the amounts of feedback amendments correspond to the future behavior of an air-fuel ratio.
[0014] Therefore, it becomes possible to perform highly precise Air Fuel Ratio Control, and buildup of a feedback period and the dry area of an air-fuel ratio can be prevented. the air-fuel ratio control system of an internal combustion engine according to claim 4 -- either of claims 1-3 -- in the configuration of a publication, said feedback gain setting-out means is characterized by changing the pattern which sets up said feedback gain according to the condition of the detection value of said linear air-fuel ratio sensor.
[0015] Here, the feedback gain setting-out means has changed the pattern which sets up the feedback gain for it not only has setting up the feedback gain for computing the amount of feedback amendments according to the detection value of a linear air-fuel ratio sensor, but computing the amount of feedback amendments according to the condition of the detection value of a linear air-fuel ratio sensor.
[0016] By this, it becomes more exactly possible to make it correspond to the future behavior of an air-fuel ratio, and a high response can be further coped with now to change of a future situation. Therefore, it becomes possible to perform still highly precise Air Fuel Ratio Control, and buildup of a feedback period and the dry area of an air-fuel ratio can be prevented.
[0017] It is characterized by for said feedback gain setting-out means classifying the detection value of said linear air-fuel ratio sensor into the condition of approaching a target air-fuel ratio, and the condition of separating from a target air-fuel ratio, in a configuration according to claim 4, and the air-fuel ratio control system of an internal combustion engine according to claim 5 changing the pattern which sets up said feedback gain for this every condition.
[0018] It can more specifically classify into the condition of approaching a target air-fuel ratio, and the condition of separating from a target air-fuel ratio, as a detection value-change condition of a linear air-fuel ratio sensor, and the pattern which sets up the feedback gain for computing the amount of feedback amendments can be changed for every conditions of these.
[0019] Thus, by changing the pattern which sets up feedback gain, it becomes more exactly possible to make it correspond to the future behavior of an air-fuel ratio, and a high response can be further coped with now to change of a future situation.
[0020] Therefore, it becomes possible to perform still highly precise Air Fuel Ratio Control, and buildup of a

feedback period and the dry area of an air-fuel ratio can be prevented. The air-fuel ratio control system of an internal combustion engine according to claim 6 is characterized by for said feedback gain setting-out means classifying the detection value of said linear air-fuel ratio sensor into the rich condition that fuel concentration is deeper than a target air-fuel ratio, and the Lean condition that fuel concentration is thinner than a target air-fuel ratio, and changing the pattern which sets up said feedback gain for this every condition in a configuration according to claim 4.

[0021] As a condition of the detection value of a linear air-fuel ratio sensor, it can classify into the rich condition that fuel concentration is deeper than a target air-fuel ratio, and the Lean condition that fuel concentration is thinner than a target air-fuel ratio, and, more specifically, the pattern which sets up the feedback gain for computing the amount of feedback amendments can be changed for every conditions of these.

[0022] Thus, by changing the pattern which sets up feedback gain, it becomes more exactly possible to make it correspond to the future behavior of an air-fuel ratio, and a high response can be further coped with now to change of a future situation.

[0023] Therefore, it becomes possible to perform still highly precise Air Fuel Ratio Control, and buildup of a feedback period and the dry area of an air-fuel ratio can be prevented. The air-fuel ratio control system of an internal combustion engine according to claim 7 In a configuration according to claim 4 said feedback gain setting-out means The condition of approaching a target air-fuel ratio in the detection value of said linear air-fuel ratio sensor from the rich condition that fuel concentration is deeper than a target air-fuel ratio, It classifies into the condition of separating from a target air-fuel ratio to a rich condition, the condition of approaching a target air-fuel ratio from the Lean condition that fuel concentration is thinner than a target air-fuel ratio, and the condition of separating from a target air-fuel ratio to the Lean condition, and is characterized by changing the pattern which sets up said feedback gain for this every condition.

[0024] Furthermore, it can more specifically classify into the condition of approaching a target air-fuel ratio from a rich condition, the condition separate from a target air-fuel ratio to a rich condition, the condition approach a target air-fuel ratio from the Lean condition, and the condition separate from a target air-fuel ratio to the Lean condition, as a detection value-change condition of a linear air-fuel ratio sensor, and the pattern which sets up the feedback gain for computing the amount of feedback amendments can be changed for every conditions of these.

[0025] Thus, by changing the pattern which sets up feedback gain, it becomes possible still more exactly to make it correspond to the future behavior of an air-fuel ratio, and a high response can be further coped with now to change of a future situation.

[0026] Therefore, it becomes possible to perform still highly precise Air Fuel Ratio Control, and buildup of a feedback period and the dry area of an air-fuel ratio can be prevented.

[0027]

[Embodiment of the Invention] [Gestalt 1 of operation] drawing 1 is a block diagram showing the outline configuration of the gasoline engine (it abbreviates to an "engine" hereafter) 4 to which invention mentioned above was applied, and its control system.

[0028] the 1st which includes a combustion chamber in the cylinder block 6 of an engine 4 -- cylinder 8 and the 2nd -- cylinder 10 and the 3rd -- cylinder 12 -- and 14 [cylinder / 4th] is formed. The inhalation-of-air path 20 is connected to each cylinders 8-14 through the intake manifold 16 and the surge tank 18. The air cleaner 22 is formed in the upstream of this inhalation-of-air path 20, and the open air is introduced in the inhalation-of-air path 20 through this air cleaner 22.

[0029] Corresponding to each cylinders 8-14, injectors 24, 26, 28, and 30 are formed in the intake manifold 16, respectively. These injectors 24-30 are electromagnetic fuel injection valves in which closing motion actuation is carried out by energization control and which inject a fuel, and the fuel in a fuel tank (graphic display abbreviation) is fed from a fuel pump (graphic display abbreviation). It is mixed with the inhalation air in an intake manifold 16, and the fuel injected from injectors 24-30 serves as gaseous mixture. This gaseous mixture is introduced to the combustion chamber of each cylinders 8-14 from the inlet port (graphic display abbreviation) it was [the inlet port] open when the intake valve (graphic display abbreviation) prepared every cylinder 8-14 opened. In feed back control of air-fuel ratio, the die length of the fuel injection duration by these injectors 24-30 is adjusted based on the feedback correction factor FAF so that it may mention later.

[0030] The throttle valve 32 which adjusts an inhalation air content is located in the upstream of a surge tank 18, and is prepared in the inhalation-of-air path 20. That opening TA, i.e., a throttle opening, is adjusted by carrying out closing motion actuation of this throttle valve 32 by the throttle motor 34 formed in the inhalation-of-air path 20. The throttle sensor 36 is formed near the throttle valve 32. This throttle sensor 36 detects the throttle opening TA, and outputs the signal according to that throttle opening TA.
[0031] Moreover, the accelerator pedal 38 is formed in the driver's cabin of an automobile, and the amount ACCP of treading in of this accelerator pedal 38, i.e., an accelerator opening, is detected by the accelerator opening sensor 40. And the electronic control (it abbreviates to "ECU" hereafter) 50 mentioned later adjusts the throttle opening TA to the opening according to operational status by controlling the throttle motor 34 based on this accelerator opening ACCP etc.
[0032] The flueway 62 is connected to each cylinders 8-14 through EGUZOSUTOMANIHORUDO 60. The catalytic converter 64 and the muffler 66 are formed in this flueway 62, respectively. The exhaust air which flows a flueway 62 passes these catalytic converters 64 and a muffler 66, and is discharged outside.
[0033] The intake-pressure sensor 68 is formed in the surge tank 18. This intake-pressure sensor 68 detects the intake pressure PM of the inhalation air introduced into the combustion chamber of each cylinders 8-14, and outputs the signal according to this intake pressure PM.
[0034] Moreover, corresponding to each cylinders 8-14, ignition plugs 70, 72, 74, and 76 are formed in cylinder head 6a of an engine 4, respectively. Each point fire plugs 70-76 are constituted as a direct ignition system which does not use a distributor, when ignition coils 70a, 72a, 74a, and 76a are attached. Each ignition coils 70a-76a have given the high tension generated based on cutoff of the upstream current supplied from the ignition actuation circuit in ECU50 at ignition timing to the direct ignition plugs 70-76.
[0035] Moreover, the linear air-fuel ratio sensor 80 is formed in the flueway 62 in the upstream from the catalytic converter 64. This linear air-fuel ratio sensor 80 outputs the current signal I according to the air-fuel ratio of the gaseous mixture which appears in the component of exhaust air, as shown in drawing 2 . And after being changed into the air-fuel ratio detection value VAF expressed with an electrical potential difference as shown in drawing 3 within ECU50, feed back control of air-fuel ratio is made so that it may mention later based on this air-fuel ratio detection value VAF, and an air-fuel ratio is adjusted to a target air-fuel ratio by the increase and decrease of processing of fuel oil consumption.
[0036] In addition, the engine-speed sensor 90 outputs the pulse signal of frequency according to the engine speed NE of an engine 4 based on rotation of the crankshaft (graphic display abbreviation) of an engine 4, and in order that the cylinder distinction sensor 92 may distinguish cylinders 8-14, it outputs the pulse signal which turns into a reference signal for whenever [predetermined crank angle / every] based on rotation of a crankshaft. ECU50 performs calculation of whenever [rotational frequency NE and crank angle], and also cylinder distinction based on the output signal from these rotational frequency sensor 90 and the cylinder distinction sensor 92.
[0037] Moreover, the coolant temperature sensor 94 for detecting engine-cooling-water ** is formed in a cylinder block 6, and the signal according to the cooling water temperature THW is outputted to it. Next, the electric configuration of the control system which has achieved the function of the air-fuel ratio control system in the gestalt 1 of this operation is explained with reference to the block diagram of drawing 4 .
[0038] ECU50 is equipped with central processing unit (CPU) 50a, read-only memory (ROM) 50b, random-access-memory (RAM) 50c, backup RAM50d, etc., and is constituted as a logic operation circuit which comes to connect input circuit 50e, 50f of output circuits etc., etc. with these each part 50a-50d by 50g of bi-directional buses. The various control programs and the various data which realize feed back control of air-fuel ratio mentioned later are beforehand memorized by ROM50b. The result of an operation of CPU50a in various control processings etc. is temporarily memorized by RAM50c.
[0039] Moreover, input circuit 50e is constituted as an input interface containing a buffer, a waveform shaping circuit, an A/D converter, etc., and the line of said throttle sensor 36, the accelerator opening sensor 40, the intake-pressure sensor 68, the linear air-fuel ratio sensor 80, the rotational frequency sensor 90, the cylinder distinction sensor 92, a coolant temperature sensor 94, and the ignition acknowledge signal IGf of each ignition coils 70a-76a etc. is connected, respectively. The output signal of the various sensors 36, 40, 68, 80, 90, and 92 and 94 grades is changed into a digital signal, and is read into CPU50a etc. from input circuit 50e through 50g of bi-directional buses.

[0040] On the other hand, 50f of output circuits has various actuation circuits etc., and said injectors 24-30, ignition coils 70a-76a, and throttle motor 34 grade are connected, respectively. ECU50 performs data processing based on the output signal from the various sensors 36, 40, 68, 80, 90, and 92 and 94 grades, and carries out actuation control of injectors 24-30, ignition coils 70a-76a, and the throttle motor 34 grade.
[0041] For example, ECU50 is controlling the fuel oil consumption by injectors 24-30, fuel injection timing, or ignition timing by ignition coils 70a-76a according to the magnitude of the load while computing the load of an engine 4 based on the engine speed NE detected by the intake pressure PM detected by the intake-pressure sensor 68, and the engine-speed sensor 90. And based on the air-fuel ratio detected by the linear air-fuel ratio sensor 80, the increase and decrease of amendment of the fuel oil consumption by injectors 24-30 are performed, and the air-fuel ratio of gaseous mixture is controlled to the target air-fuel ratio at the precision to mention later.
[0042] Next, the feed back control of air-fuel ratio performed by ECU50 in the gestalt 1 of this operation is explained based on an R> 5 or less drawing 5 flow chart. In addition, the step in the flow chart corresponding to each processing is expressed with "S-."
[0043] Feedback correction factor FAF calculation processing is shown in the flow chart of drawing 5 . This processing is processing repeatedly performed for every fixed crank angle. Initiation of this feedback correction factor FAF calculation processing reads into the working area of RAM50c the air-fuel ratio detection value VAF acquired from the signal of the engine speed NE first obtained from the signal of the accelerator opening ACCP obtained from the signal of the accelerator opening sensor 40, and the engine-speed sensor 90, and the linear air-fuel ratio sensor 80 (S110).
[0044] Next, the target air-fuel ratio VAFt is set up (S120). Although the value equivalent to theoretical air fuel ratio is set to the target air-fuel ratio VAFt here by the type which an engine 4 controls only to theoretical air fuel ratio at the time of feed back control of air-fuel ratio With a lean burn engine etc., when an engine 4 performs the combustion system in an air-fuel ratio (the "Lean air-fuel ratio" is called hereafter) with fuel concentration thinner than theoretical air fuel ratio in addition to theoretical air fuel ratio Based on the operational status of an engine 4, for example, the accelerator opening ACCP and an engine speed NE, the suitable target air-fuel ratio VAFt is set up from the map before the theoretical-air-fuel-ratio - Lean air-fuel ratio. Here, let an engine 4 be a lean burn engine.
[0045] Next, as shown in the degree type 1, air-fuel ratio deflection deltaVAF showing the deflection from the target air-fuel ratio VAFt in the air-fuel ratio detection value VAF is calculated (S130).
[0046]
[Equation 1]
deltaVAF <- VAF - VAFt -- [Formula 1]
Next, feedback proportional gain Kp setting-out processing is performed (S140). The detail of this feedback proportional gain Kp setting-out processing is shown in the flow chart of drawing 6 . In this feedback proportional gain Kp setting-out processing, air-fuel ratio detection value VAF condition judging processing is performed first (S210). The detail of this air-fuel ratio detection value VAF condition judging processing is shown in the flow chart of drawing 7 and drawing 8 R> 8.
[0047] In this air-fuel ratio detection value VAF condition judging processing, it is first judged for the air-fuel ratio detection value VAF detected by the linear air-fuel ratio sensor 80 whether it is below VAFt (S310). If it is VAF<=VAFt (it is "YES" at S310) next, it will be judged for the air-fuel ratio detection value VAF whether it is below the rich peak decision value VAFR (S320). In addition, as for the RIN peak decision value VAFL which it rich-peak-decision-value-VAFR(s), and is mentioned later, the target air-fuel ratio VAFt is set up as initial setting.
[0048] If it is VAF<=VAFR (it is "YES" at S320), "a condition 1" will be set as the variable PHS showing the condition of the air-fuel ratio detection value VAF (S330). And the new rich peak decision value VAFR is computed by count (it calls "annealing and calculating" hereafter) of a weighting average value like the degree type 2 (S340).
[0049]
[Equation 2]
VAFR <- (VAFRxn + VAF) /(n+1) -- [Formula 2]
Here, as for n, a forward decimal and one or more suitable numeric values are set up.

[0050] Next, the target air-fuel ratio VAFt is set as the RIN peak decision value VAFL (S350), and this processing is once ended. On the other hand, if it is VAF>VAFR (it is "NO" at S320), "a condition 2" will be set as the VAF state variable PHS (S360). And the new rich peak decision value VAFR is computed like the degree type 3 (S370).
[0051]
[Equation 3]
VAFR <- VAF - deltaOFFSET -- [Formula 3]
Here, the suitable value for offset value deltaOFFSET to separate the rich peak decision value VAFR from the air-fuel ratio detection value VAF to the smaller one is set up.
[0052] Next, the target air-fuel ratio VAFt is set as the RIN peak decision value VAFL (S350), and this processing is once ended. At step S310, if it is VAF>VAFt (it is "NO" at S310) next, it will be judged whether the air-fuel ratio detection value VAF is over the RIN peak decision value VAFL (S380).
[0053] If it is VAF>VAFR (it is "YES" at S380), "a condition 3" will be set as the VAF state variable PHS (S390). And like the degree type 4, it anneals and the new RIN peak decision value VAFL is computed by count (S400).
[0054]
[Equation 4]
VAFL <- (VAFLxn + VAF) /(n+1) -- [Formula 4]
Here, as for n, a forward decimal and one or more suitable numeric values are set up.
[0055] Next, the target air-fuel ratio VAFt is set as the rich peak decision value VAFR (S410), and this processing is once ended. On the other hand, if it is VAF<=VAFL (it is "NO" at S380), "a condition 4" will be set as the VAF state variable PHS (S420). And the new RIN peak decision value VAFL is computed like the degree type 5 (S430).
[0056]
[Equation 5]
VAFL <- VAF + deltaOFFSET -- [Formula 5]
Here, the suitable value for offset value deltaOFFSET to separate the RIN peak decision value VAFL from the air-fuel ratio detection value VAF to the larger one is set up.
[0057] Next, the target air-fuel ratio VAFt is set as the rich peak decision value VAFR (S410), and this processing is once ended. By air-fuel ratio detection value VAF condition judging processing mentioned above, as an example is shown in drawing 9 , the VAF state variable PHS will be set up. That is, the condition of approaching the target air-fuel ratio VAFt from "a condition 3" and the Lean condition in the condition of separating the condition of approaching the target air-fuel ratio VAFt from "a condition 1" and a rich condition in the condition of separating from the target air-fuel ratio VAFt to a rich condition, from "a condition 2" and the target air-fuel ratio VAFt to the Lean condition is classified as "a condition 4."
[0058] If the VAF state variable PHS is set as processing of drawing 6 by air-fuel ratio detection value VAF condition judging processing of return and step S210, based on the VAF state variable PHS, a feedback proportional gain Kp map will be chosen next (S220).
[0059] The feedback proportional gain Kp map for every VAF state variable PHS of this is shown in drawing 10 - drawing 13 . As for drawing 1010 , "a condition 2" and drawing 12 express "a condition 3", and drawing 13 expresses ["a condition 1" and drawing 11] the feedback proportional gain Kp map of "a condition 4." As illustrated, in each VAF state variable PHS, the feedback proportional gain Kp is changing according to air-fuel ratio deflection deltaVAF. Conventionally, as a graphic display broken line showed, it did not depend on the value of air-fuel ratio deflection deltaVAF, but fixed.
[0060] Selection of the feedback proportional gain Kp map of either drawing 10 - drawing 13 sets up the feedback proportional gain Kp on the selected feedback proportional gain Kp map at step S220 based on air-fuel ratio deflection deltaVAF (S230). In this way, feedback proportional gain Kp setting-out processing is once ended.
[0061] If the feedback proportional gain Kp is set as drawing 5 at return and step S140 next, as shown in the degree type 6, the feedback correction factor FAF (it is equivalent to the amount of feedback amendments) will be computed (S150).
[0062]

[Equation 6]
FAF <- Kpxdelta VAF + KIxsigma (deltaVAF) + 1.0 -- [Formula 6]
Here, "Kpxdelta VAF" expresses the proportional of feedback control, "KIxsigma (deltaVAF)" expresses the integral term of feedback control, "sigma (deltaVAF)" expresses the integral value of air-fuel ratio deflection deltaVAF, and KI expresses feedback integral gain. In addition, it does not depend for this feedback integral gain KI on air-fuel ratio deflection deltaVAF with the gestalt 1 of this operation, but constant value is used.
[0063] In this way, feedback correction factor FAF calculation processing is once ended. Thus, the called-for feedback correction factor FAF is used in the fuel-injection processing shown in the flow chart of drawing 14 . This fuel-injection processing is repeatedly performed for every fixed crank angle.
[0064] Initiation of fuel-injection processing finds the basic fuel injection valve valve-opening time amount TP from the map MTP memorized by ROM50b first based on an engine speed NE and an intake pressure PM (S510).
[0065] Next, based on values, such as the feedback correction factor FAF computed by this basic fuel injection valve valve-opening time amount TP and feedback correction factor FAF calculation processing (drawing 5), the fuel injection valve valve-opening time amount TAU is calculated by the degree type 7 (S520).
[0066]
[Equation 7]
TAU <- K3, TP, and {FAF + KG(m)}+K4 -- [Formula 7]
Here, KG (m) is the study value which acquired the condition of the deflection of the feedback correction factor FAF from "1.0" by study processing. Moreover, K3 and K4 are other correction factors.
[0067] Next, the fuel injection valve valve-opening time amount TAU is outputted (S530), and fuel-injection processing is once ended. An example of the control performed in the configuration mentioned above is shown in drawing 15 . In drawing 1515 , the continuous line of (A) expresses the air-fuel ratio detection value VAF. (B) expresses the condition of the feedback correction factor FAF. As shown also in this Fig., the change pattern of the feedback correction factor FAF is shifted before in time, and has become a thing in consideration of a future air-fuel ratio change from the change pattern of the air-fuel ratio detection value VAF.
[0068] In the configuration of the gestalt 1 of operation mentioned above, feedback correction factor FAF calculation processing (drawing 5), feedback proportional gain Kp setting-out processing (drawing 6), and air-fuel ratio detection value VAF condition judging processing (drawing 7 , drawing 8) are equivalent to a feedback gain setting-out means.
[0069] According to the gestalt 1 of this operation explained above, the following effectiveness is acquired. The feedback proportional gain Kp used for calculation of the feedback correction factor FAF at the (b) . step S150 is computed in step S230 based on air-fuel ratio deflection deltaVAF from either of the feedback proportional gain Kp maps shown in drawing 10 - drawing 13 .
[0070] Since this air-fuel ratio deflection deltaVAF expresses the deflection from the target air-fuel ratio VAFt in the air-fuel ratio detection value VAF, it becomes possible [the feedback proportional gain Kp for computing the feedback correction factor FAF being set up according to the air-fuel ratio detection value VAF, and setting up the feedback proportional gain Kp which took into consideration beforehand the future behavior of the air-fuel ratio which has appeared in the air-fuel ratio detection value VAF of the linear air-fuel ratio sensor 80].
[0071] Therefore, as shown in drawing 10 - drawing 13 , the feedback correction factor FAF corresponding to change of a future situation is set up, and it becomes possible to perform highly precise Air Fuel Ratio Control, and buildup of a feedback period and the dry area of an air-fuel ratio can be prevented.
[0072] In addition, the feedback proportional gain Kp for asking especially for a proportional is set up also among the feedback correction factors FAF. A proportional can cope with promptly fluctuation of the air-fuel ratio detection value VAF as compared with an integral term. By this, a high response can be coped with more now to change of a future situation also among the feedback correction factors FAF by making the feedback proportional gain Kp for asking for a proportional correspond to the air-fuel ratio detection value VAF.
[0073] The pattern of the feedback proportional gain Kp to the (b) . air-fuel ratio detection value VAF is changed according to the condition of the air-fuel ratio detection value VAF. Specifically, it is classified into the "condition 1" that the air-fuel ratio detection value VAF separates from the target air-fuel ratio VAFt to a rich condition, the "condition 2" of approaching the target air-fuel ratio VAFt from a rich condition, and the "condition 3" of separating from the target air-fuel ratio VAFt to the Lean condition and the "condition 4" of

approaching the target air-fuel ratio VAFt from the Lean condition. And as shown in drawing 10 - drawing 13 , the pattern which sets up the feedback proportional gain Kp for computing the feedback correction factor FAF is changed for every conditions of these.
[0074] Here, in the condition 1 that the air-fuel ratio detection value VAF separates from the target air-fuel ratio VAFt to a rich condition, as shown in drawing 10 , the feedback proportional gain Kp from the location near "0" with already large air-fuel ratio deflection deltaVAF which is a negative value is shown. Therefore, the contribution to the feedback correction factor FAF will become a high level. By this, the feedback control which predicted the next air-fuel ratio change, i.e., the change by the side of rich, in the condition 1 becomes possible. And air-fuel ratio deflection deltaVAF follows for becoming small (an absolute value becoming large), and the feedback proportional gain Kp becomes small once gradually. It becomes what was stabilized by this even if the contribution to the feedback correction factor FAF was a high level, and the transient overshoot of control can be prevented. When air-fuel ratio deflection deltaVAF becomes still smaller (an absolute value still more greatly), extreme rich-ization of an air-fuel ratio is prevented by changing the feedback proportional gain Kp to the larger one again.
[0075] In the "condition 2" that the air-fuel ratio detection value VAF approaches the target air-fuel ratio VAFt from a rich condition, the feedback proportional gain Kp is becoming small gradually as were shown in drawing 11 and air-fuel ratio deflection deltaVAF which is a negative value approaches "0" from a small (an absolute value is large) value. Therefore, when the air-fuel ratio detection value VAF is separated from the target air-fuel ratio VAFt, while functioning as bringing close to the target air-fuel ratio VAFt quickly, if it becomes near the target air-fuel ratio VAFt, the feedback proportional gain Kp will approach "0." The feedback control which predicted having become near the target air-fuel ratio VAFt by this becomes possible.
[0076] In the "condition 3" that the air-fuel ratio detection value VAF separates from the target air-fuel ratio VAFt to the Lean condition, as shown in drawing 12 , the feedback proportional gain Kp from the location near "0" with already large air-fuel ratio deflection deltaVAF which is a forward value is shown. Therefore, the contribution to the feedback correction factor FAF will become a high level. By this, the feedback control which predicted the next air-fuel ratio change, i.e., the change by the side of Lean, in the condition 3 becomes possible. And the feedback proportional gain Kp becomes small once gradually as air-fuel ratio deflection deltaVAF becomes large. It becomes what was stabilized by this even if the contribution to the feedback correction factor FAF was a high level, and the transient overshoot of control can be prevented. When air-fuel ratio deflection deltaVAF becomes still larger, Lean-ization with a going too far air-fuel ratio is prevented by changing the feedback proportional gain Kp to the larger one again.
[0077] In the "condition 4" that the air-fuel ratio detection value VAF approaches the target air-fuel ratio VAFt from the Lean condition, the feedback proportional gain Kp is becoming small gradually as were shown in drawing 13 and air-fuel ratio deflection deltaVAF which is a forward value approaches "0" gradually from a large value. Therefore, when the air-fuel ratio detection value VAF is separated from the target air-fuel ratio VAFt, while functioning as bringing close to the target air-fuel ratio VAFt quickly, if it becomes near the target air-fuel ratio VAFt, the feedback proportional gain Kp will approach "0." The feedback control which predicted having become near the target air-fuel ratio VAFt by this becomes possible.
[0078] Thus, by changing the pattern which sets up the feedback proportional gain Kp, it becomes possible still more exactly to make it correspond to the future behavior of an air-fuel ratio, and a high response can be further coped with now to change of a future situation. Therefore, it becomes possible to perform still highly precise Air Fuel Ratio Control, and buildup of a feedback period and the dry area of an air-fuel ratio can be prevented.
[0079] With the gestalt 2 of the [gestalt 2 of operation] book operation, in order to set up also about the feedback integral gain KI based on air-fuel ratio deflection deltaVAF, it differs from the gestalt 1 of said operation in that processing shown in drawing 16 instead of feedback correction factor FAF calculation processing of drawing 5 of the gestalt 1 of said operation is performed. About other configurations, it is the same as the gestalt 1 of said operation.
[0080] Moreover, in feedback correction factor FAF calculation processing of drawing 16 , processings other than processing of step S645 are the respectively same processings as steps S110-S150 of the gestalt 1 of said operation, and processing of a step number in which 500 was added to the step number given to processing of drawing 5 corresponds.
[0081] At step S645 of the gestalt 2 of this operation, the feedback integral gain KI is set up based on air-fuel

ratio deflection deltaVAF according to the feedback integral gain KI map shown in drawing 17 .
[0082] And at step S650, the feedback correction factor FAF is computed using this feedback integral gain KI and the feedback proportional gain Kp set up at step S640.
[0083] As PL shows to the timing chart of drawing 1818 by performing such processing, even if an air-fuel ratio shifts to the Lean side greatly temporarily, as PI shows, with the feedback proportional gain Kp, the feedback integral gain KI also increases and the gap with the target air-fuel ratio VAFt is promptly made small. It is also the same as when it shifts to a rich side greatly.
[0084] In the configuration of the gestalt 2 of operation mentioned above, feedback correction factor FAF calculation processing (drawing 16), and the feedback proportional gain Kp setting-out processing (drawing 6) and air-fuel ratio detection value VAF condition judging processing (drawing 7 , drawing 8) which were shown with the gestalt 1 of said operation are equivalent to a feedback gain setting-out means.
[0085] According to the gestalt 2 of this operation explained above, the following effectiveness is acquired.
(b) of the gestalt 1 of the (b) . aforementioned implementation and the effectiveness of (b) arise.
Since it is set up according to air-fuel ratio deflection deltaVAF also about the (b) . feedback integral gain KI, corresponding to change of a future situation, it becomes possible to set the feedback correction factor FAF as a high response more. Therefore, it becomes possible to perform highly precise Air Fuel Ratio Control, and buildup of a feedback period and the dry area of an air-fuel ratio can be prevented.
[0086] With the gestalt 3 of the [gestalt 3 of operation] book operation, the feedback correction factor FAF calculation processing shown in drawing 19 and drawing 20 , and air-fuel ratio detection value VAF condition judging processing shown in 21 are performed instead of the feedback correction factor FAF calculation processing (drawing 5) in the gestalt 1 of said operation, and air-fuel ratio detection value VAF condition judging processing (drawing 7 , 8). About feedback proportional gain Kp setting-out processing (drawing 6) and other configurations, it is the same as the gestalt 1 of said operation.
[0087] In processing of drawing 19 , steps S710, S720, S740, and S750 are the same as processing of steps S110, S120, S140, and S150 of drawing 5 respectively except for step S745. In addition, step S745 is performed by the degree of step S740 as processing corresponding to step S130 of drawing 5 R> 5.
[0088] Step S745 calculates air-fuel ratio deflection deltaVAF by the degree type 8.
[0089]
[Equation 8]
deltaVAF <- VAF - VAFJ -- [Formula 8]
The air-fuel ratio decision value VAFJ is a value set up by the air-fuel ratio detection value VAF condition judging processing mentioned later.
[0090] In drawing 20 and processing of 21, processing of a step number in which 400 was added to drawing 7 and the step number given to processing of 8 corresponds except for steps S810, S850, S875, S910, and S935.
[0091] At step S810, the air-fuel ratio detection value VAF has judged the Lean and rich side from the air-fuel ratio decision value VAFJ among drawing 20 and processing of 21. Moreover, at step S850 performed when it is VAF<=VAFJ (it is "YES" at S810), the air-fuel ratio decision value VAFJ is set as the RIN peak decision value VAFL. Furthermore, at step S875 which is performed in VAF>VAFR (it is "NO" at S820), as shown in the degree type 9, the air-fuel ratio decision value VAFJ is set up.
[0092]
[Equation 9]
VAFJ <- VAFt - dV -- [Formula 9]
Here, the offset value dV is a value for setting up the air-fuel ratio decision value VAFJ smaller than the target air-fuel ratio VAFt.
[0093] Moreover, at step S910 performed when it is VAF>VAFJ (it is "NO" at S810), the air-fuel ratio decision value VAFJ is set as the rich peak decision value VAFR. Furthermore, at step S935 which is performed in VAF<=VAFL (it is "NO" at S880), as shown in the degree type 10, the air-fuel ratio decision value VAFJ is set up.
[0094]
[Equation 10]
VAFJ <- VAFt + dV -- [Formula 10]
Here, the offset value dV is a value for making the air-fuel ratio decision value VAFJ larger than the target air-

fuel ratio VAFt.
[0095] Since it is constituted in this way, the gestalt 3 of this operation is changed so that reversal of Air Fuel Ratio Control may become [the level (air-fuel ratio decision value VAFJ) for judging the Lean condition and a rich condition] early. For this reason, as shown in the timing chart of drawing 22 , the period of "a condition 2" or "a condition 4" becomes short, and comes to shift to "a condition 3" or "a condition 1" at an early stage. Therefore, a feedback period becomes short also as the whole.
[0096] In the configuration of the gestalt 3 of operation mentioned above, feedback correction factor FAF calculation processing (drawing 19), feedback proportional gain Kp setting-out processing (drawing 6), and air-fuel ratio detection value VAF condition judging processing (drawing 20 , drawing 21) are equivalent to a feedback gain setting-out means.
[0097] According to the gestalt 3 of this operation explained above, the following effectiveness is acquired.
(b) of the gestalt 1 of the (b) . aforementioned implementation and the effectiveness of (b) arise.
Since the air-fuel ratio decision value VAFJ the (b) . air-fuel ratio detection value VAF judges a Lean and rich side to be is set up so that the judgment between the Lean side and a rich side may change at an early stage using the target air-fuel ratio VAFt, a feedback period becomes still shorter as shown in drawing 22 . For this reason, it becomes possible to perform highly precise Air Fuel Ratio Control.
[0098] [The gestalt of other operations]
- In the gestalt of each aforementioned implementation, although it was equipment which performs Air Fuel Ratio Control by adjusting injection fuel quantity, the equipment of the type which controls an air-fuel ratio by feedback adjustment to the opening of a throttle valve 32 in addition to this may be used. In this case, the feedback proportional gain Kp and the feedback integral gain KI are used in order to calculate the feedback correction factor in the feedback control to the throttle opening TA.
[0099] - In the gestalt of each aforementioned implementation, although the condition of the air-fuel ratio detection value VAF was classified into the condition of "conditions 1-4", you may classify into two according to a Lean and rich side from the target air-fuel ratio VAFt or the air-fuel ratio decision value VAFJ in addition to this, and may classify into two according to the direction approaching the target air-fuel ratio VAFt or the air-fuel ratio decision value VAFJ, or the direction to leave.
[0100] - Instead of the thing feedback proportional gain Kp map (drawing 11) in the "condition 2" of having been used in the gestalt of each aforementioned implementation, as shown in drawing 23 , air-fuel ratio deflection deltaVAF may use the map set to feedback proportional gain Kp<0 by Tokoro near "0." Similarly, instead of the thing feedback proportional gain Kp map (drawing 13) in "a condition 4", as shown in drawing 24 , air-fuel ratio deflection deltaVAF may use the map set to feedback proportional gain Kp<0 by Tokoro near "0."
[0101] As mentioned above, although the gestalt of operation of this invention was explained, it appends that it is a thing including the following gestalten to the gestalt of operation of this invention.
(1) Air-fuel ratio control system of the internal combustion engine characterized by setting the value which carried out increase and decrease of the target air-fuel ratio of amendment according to the condition of the detection value of a linear air-fuel ratio sensor as said air-fuel ratio decision value so that an air-fuel ratio decision value may be used instead of a target air-fuel ratio and the detection value of a linear air-fuel ratio sensor may cross this air-fuel ratio decision value at an early stage in one configuration of . claims 1-7.
[0102] (2) The linear air-fuel ratio sensor by which . output is proportional to an internal combustion engine's air-fuel ratio mostly is used. It is the air-fuel ratio control system of the internal combustion engine which does feedback control of the air-fuel ratio of the gaseous mixture which computes the amount of feedback amendments based on the deflection from the target air-fuel ratio in the detection value of this linear air-fuel ratio sensor, and is supplied to an internal combustion engine's combustion chamber based on this amount of feedback amendments to a target air-fuel ratio. The air-fuel ratio control system of the internal combustion engine characterized by having a feedback gain setting-out means to set up the feedback gain for computing said amount of feedback amendments, according to the deflection from the target air-fuel ratio in the detection value of said linear air-fuel ratio sensor.
[0103] (3) It is the air-fuel ratio control system of the internal combustion engine characterized by setting up feedback proportional gain for said feedback gain setting-out means asking for a proportional among said amounts of feedback amendments in a configuration given in . (2) according to the deflection from the target

air-fuel ratio in the detection value of said linear air-fuel ratio sensor.
[0104] (4) It is the air-fuel ratio control system of the internal combustion engine characterized by setting up feedback proportional gain for said feedback gain setting-out means asking for a proportional among said amounts of feedback amendments in a configuration given in . (2), and the feedback integral gain for searching for an integral term according to the deflection from the target air-fuel ratio in the detection value of said linear air-fuel ratio sensor.

[Translation done.]

* NOTICES *

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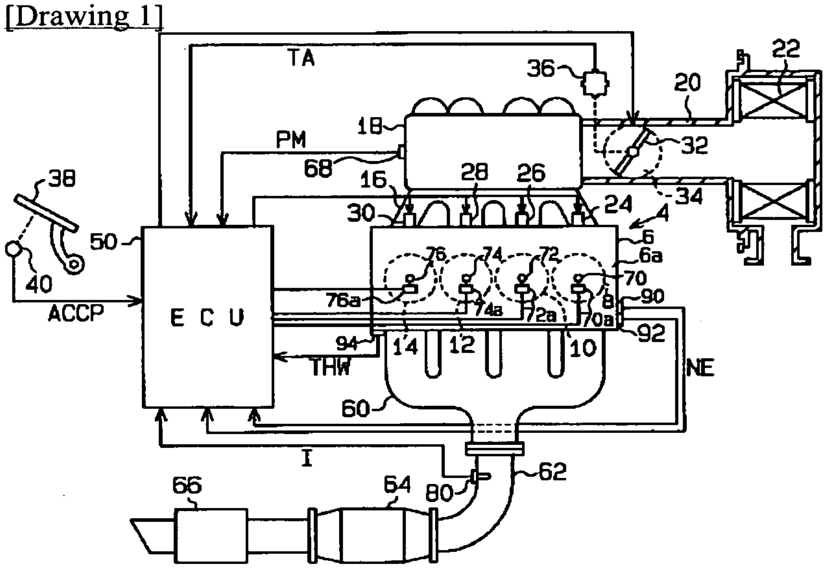
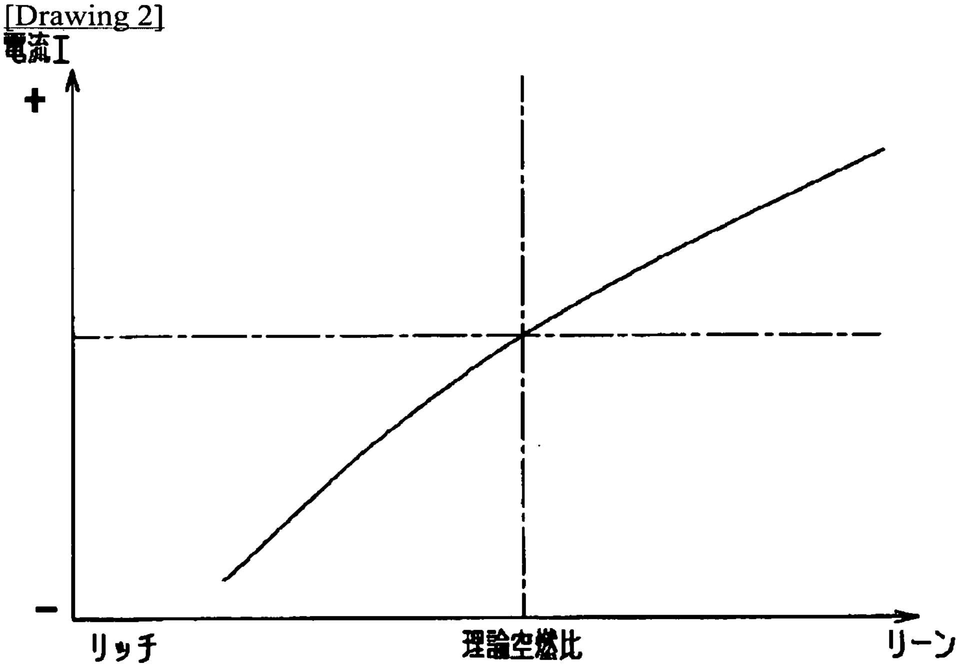
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

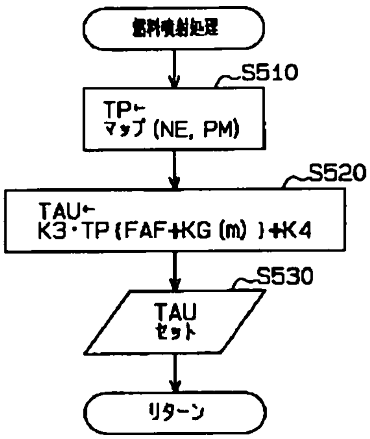
[Drawing 1]



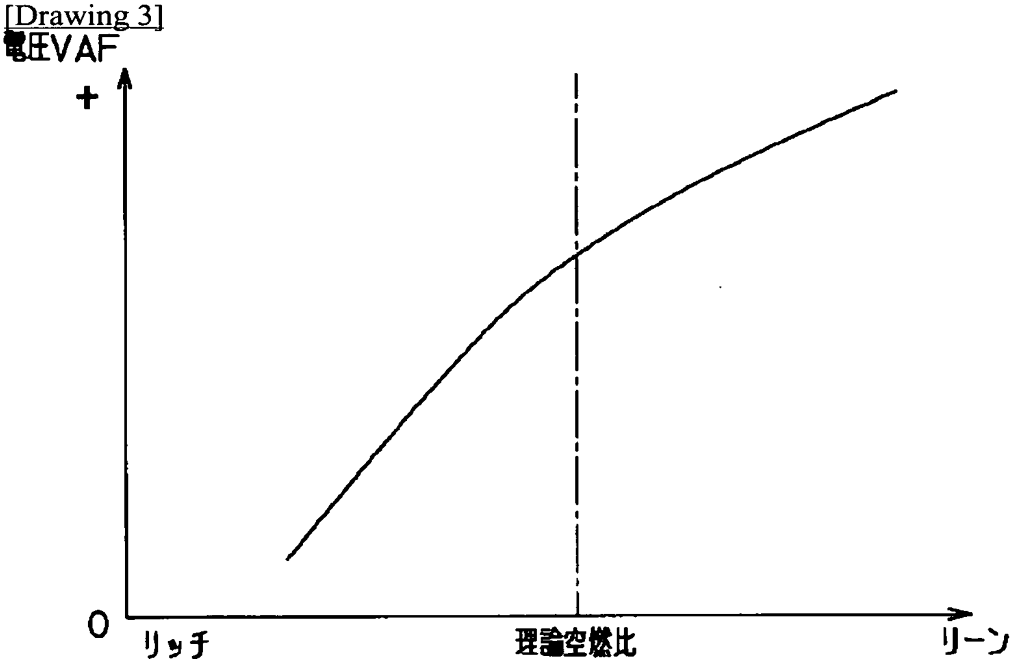
[Drawing 2]



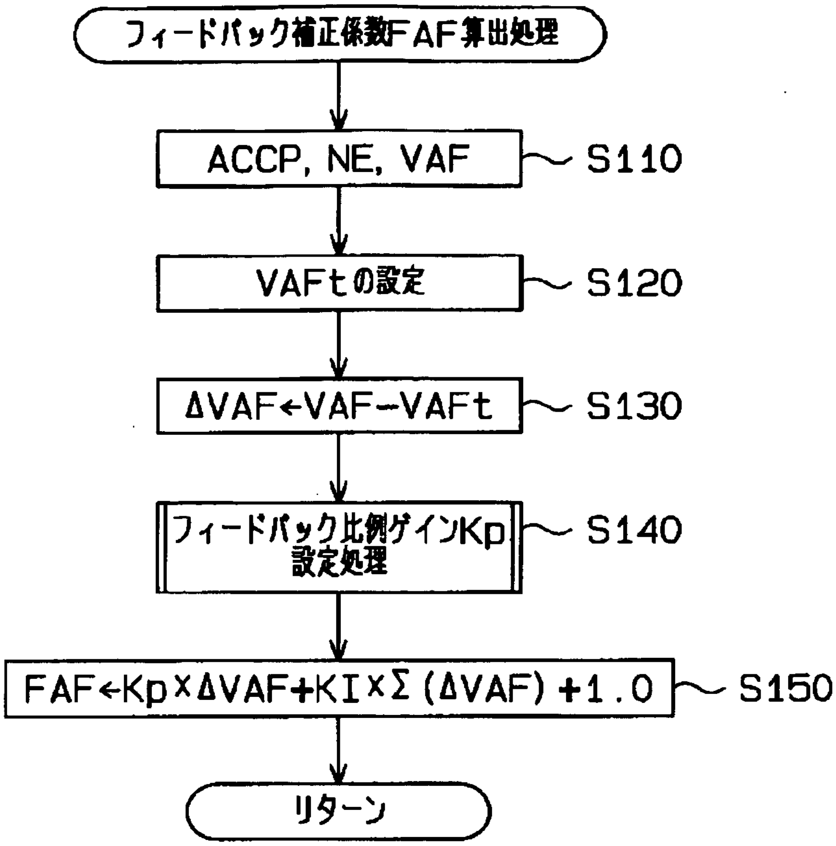
[Drawing 14]



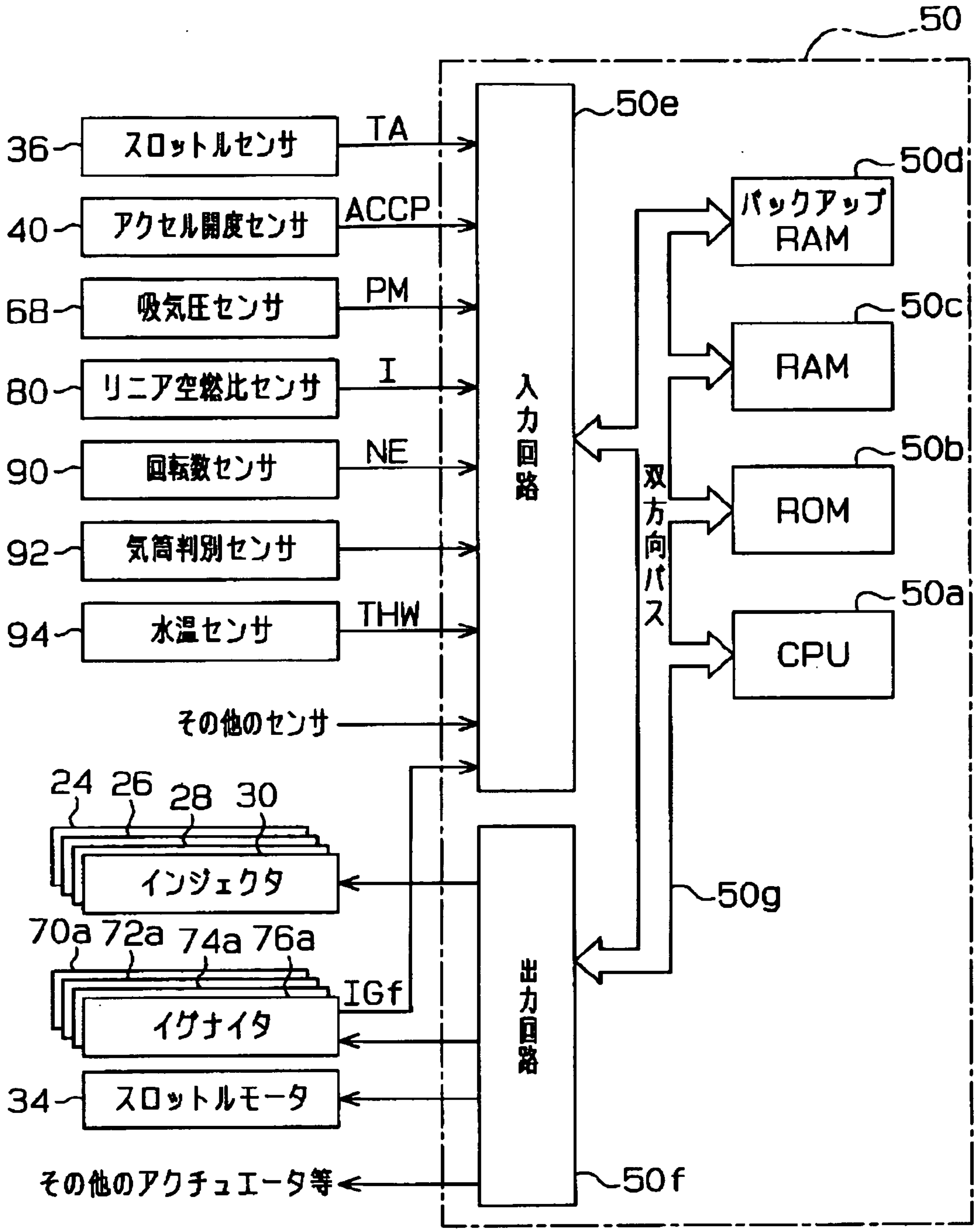
[Drawing 3]



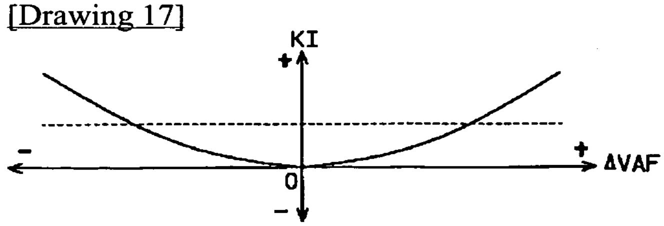
[Drawing 5]


フィードバック補正係数FAF算出処理
ACCP, NE, VAF
S110
VAFtの設定
S120
ΔVAF←VAF−VAFt
S130
フィードバック比例ゲインKp設定処理
S140
FAF←Kp×ΔVAF+KI×Σ(ΔVAF)+1.0
S150
リターン

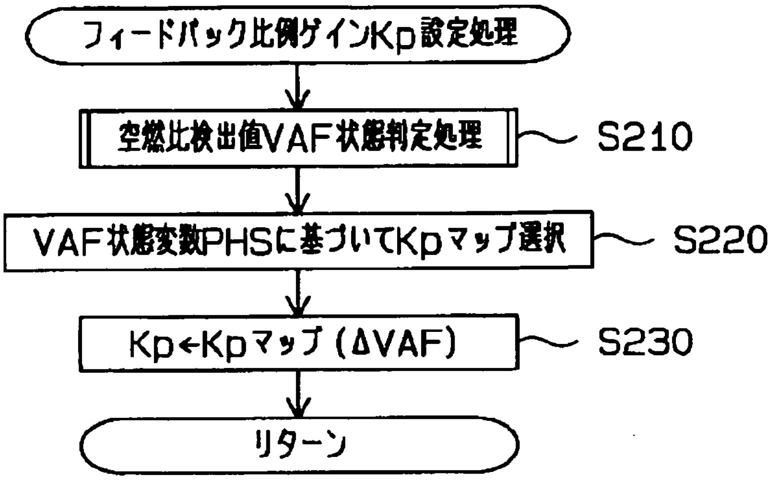
[Drawing 4]



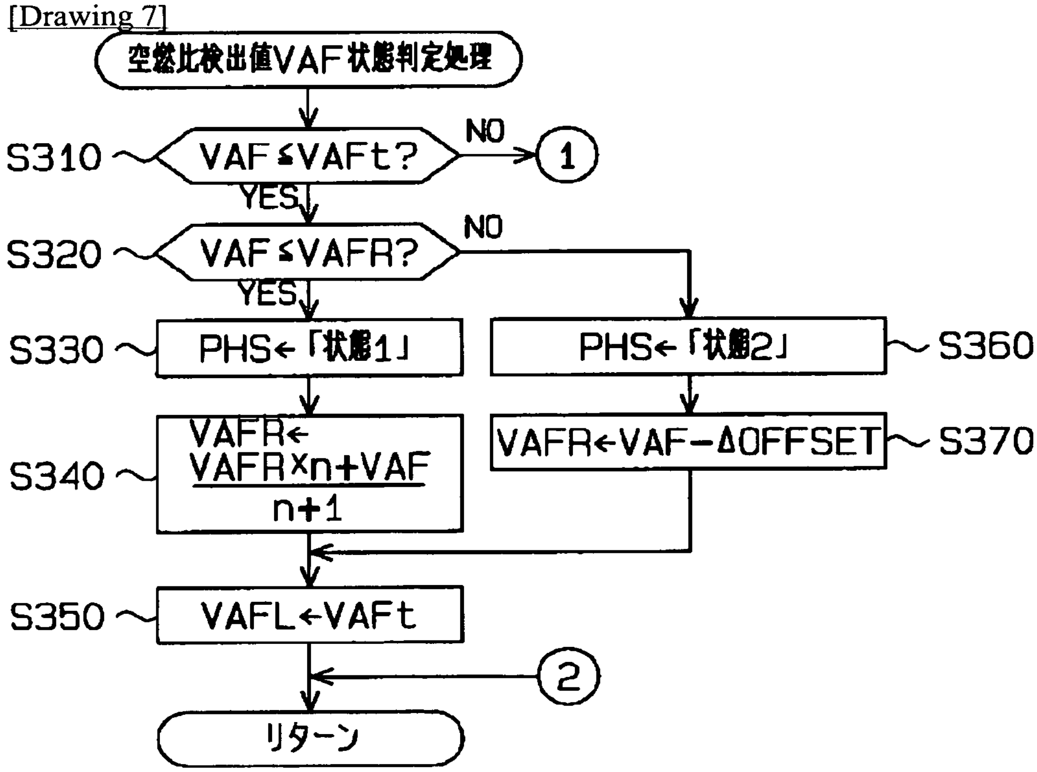
[Drawing 17]



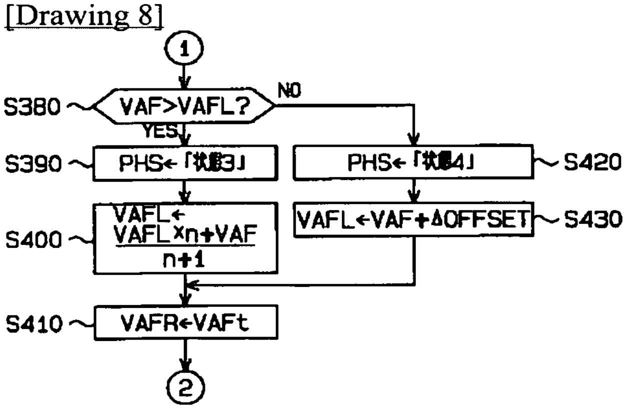
[Drawing 6]



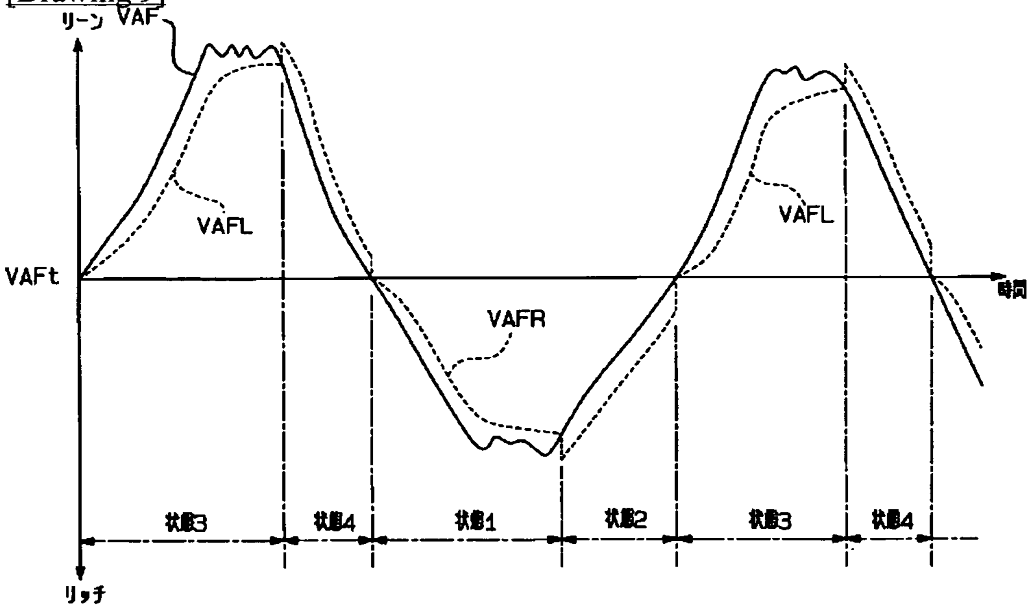
[Drawing 7]



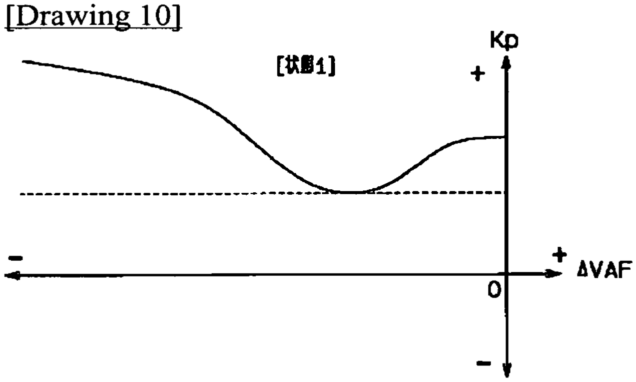
[Drawing 8]



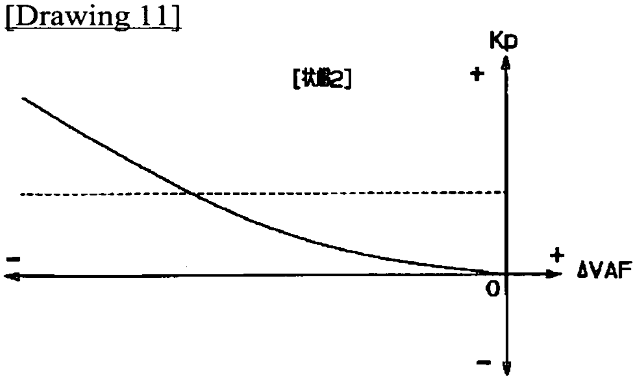
[Drawing 9]



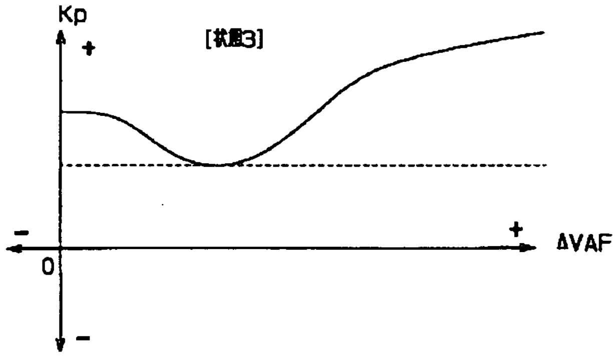
[Drawing 10]



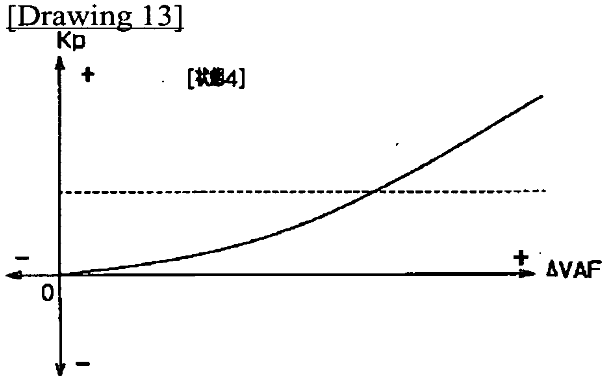
[Drawing 11]



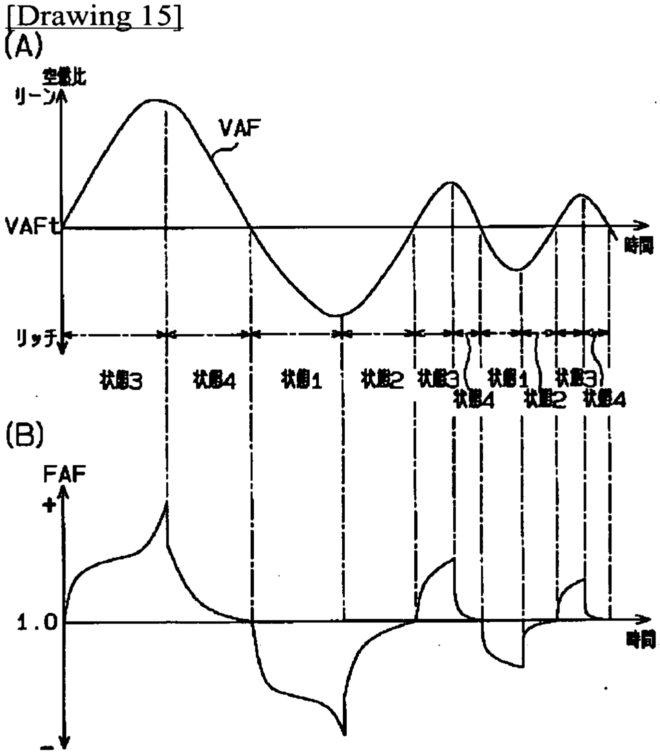
[Drawing 12]



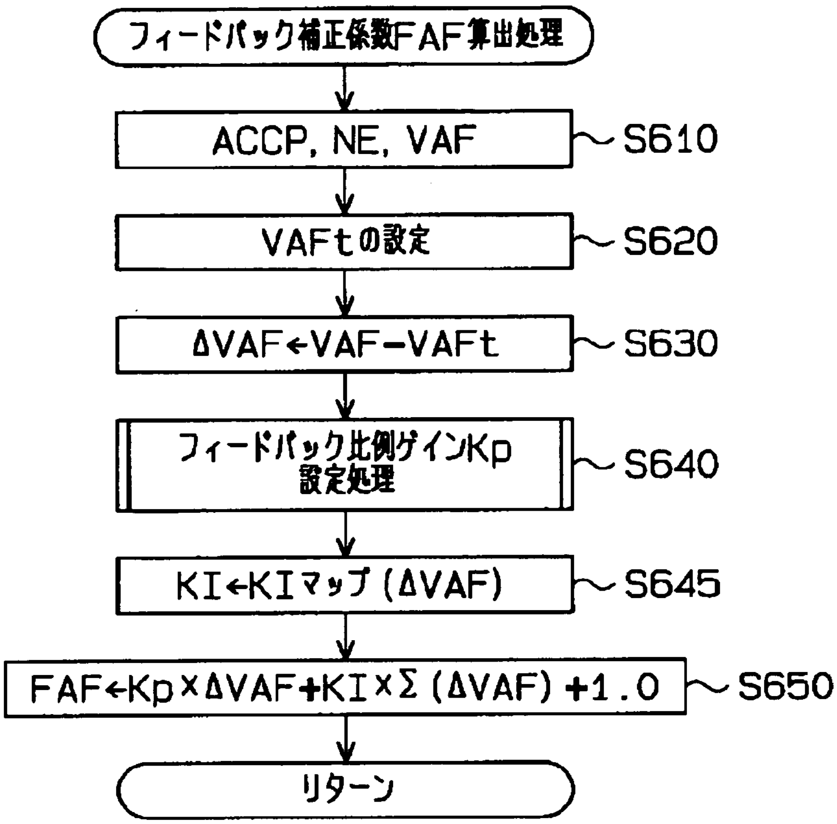
[Drawing 13]



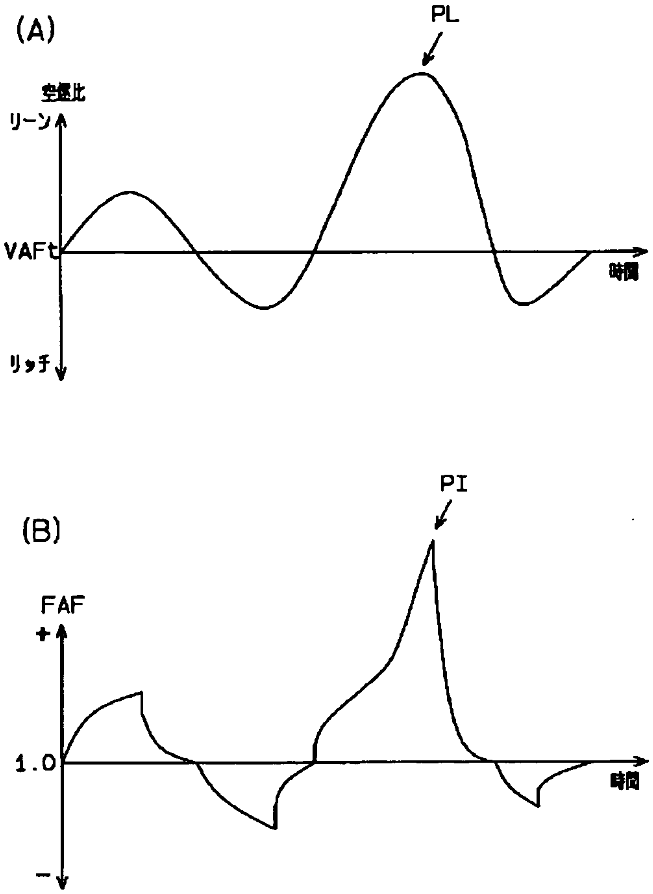
[Drawing 15]



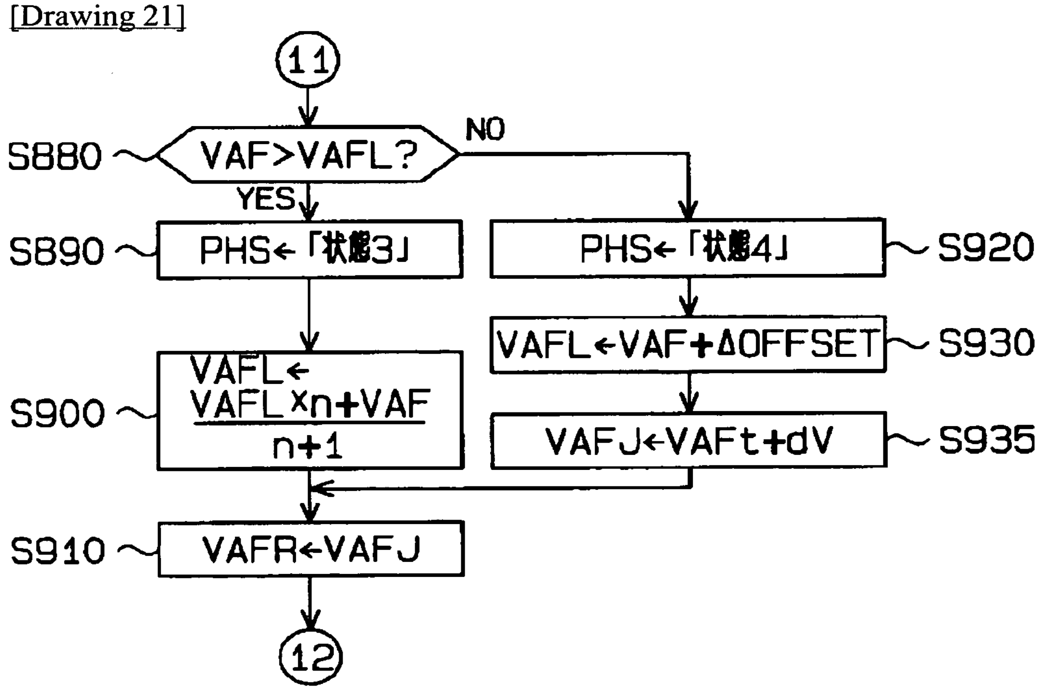
[Drawing 16]


フィードバック補正係数FAF算出処理
ACCP, NE, VAF
S610
VAFtの設定
S620
ΔVAF←VAF−VAFt
S630
フィードバック比例ゲインKp
設定処理
S640
KI←KIマップ(ΔVAF)
S645
FAF←Kp×ΔVAF+KI×Σ(ΔVAF)+1.0
S650
リターン

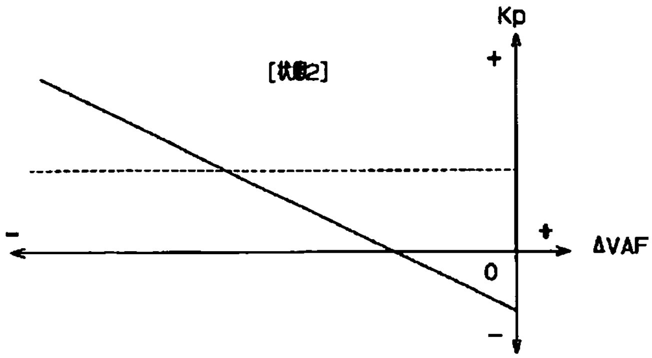
[Drawing 18]



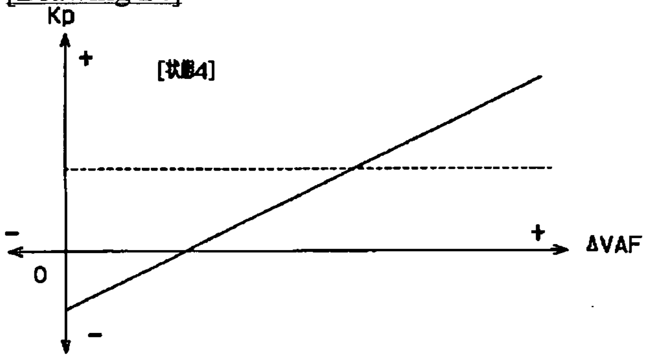
[Drawing 21]



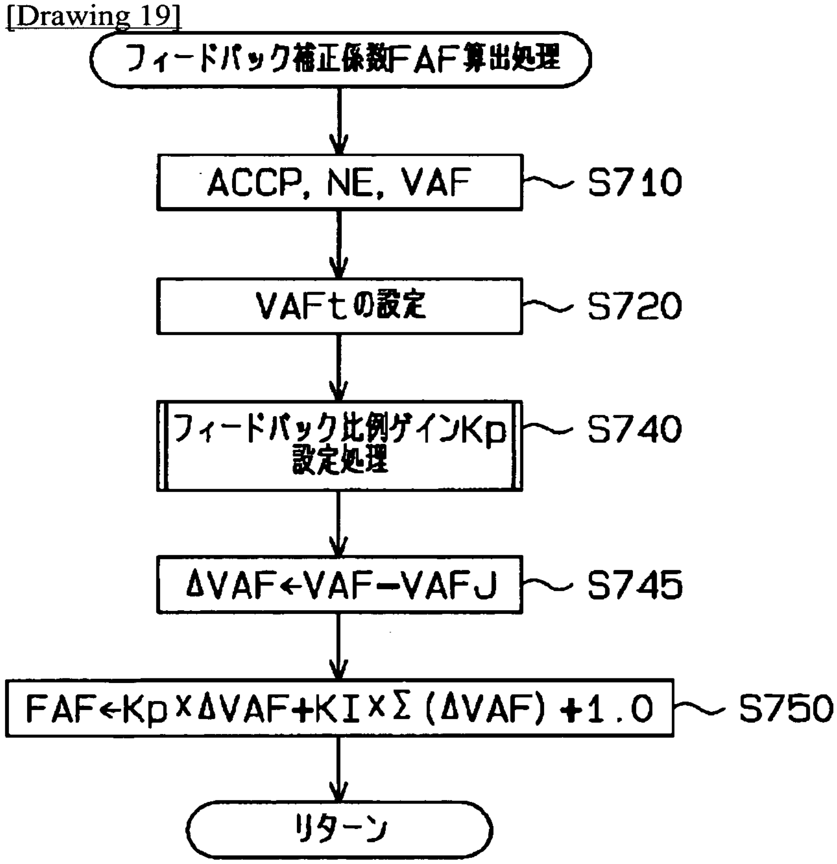
[Drawing 23]



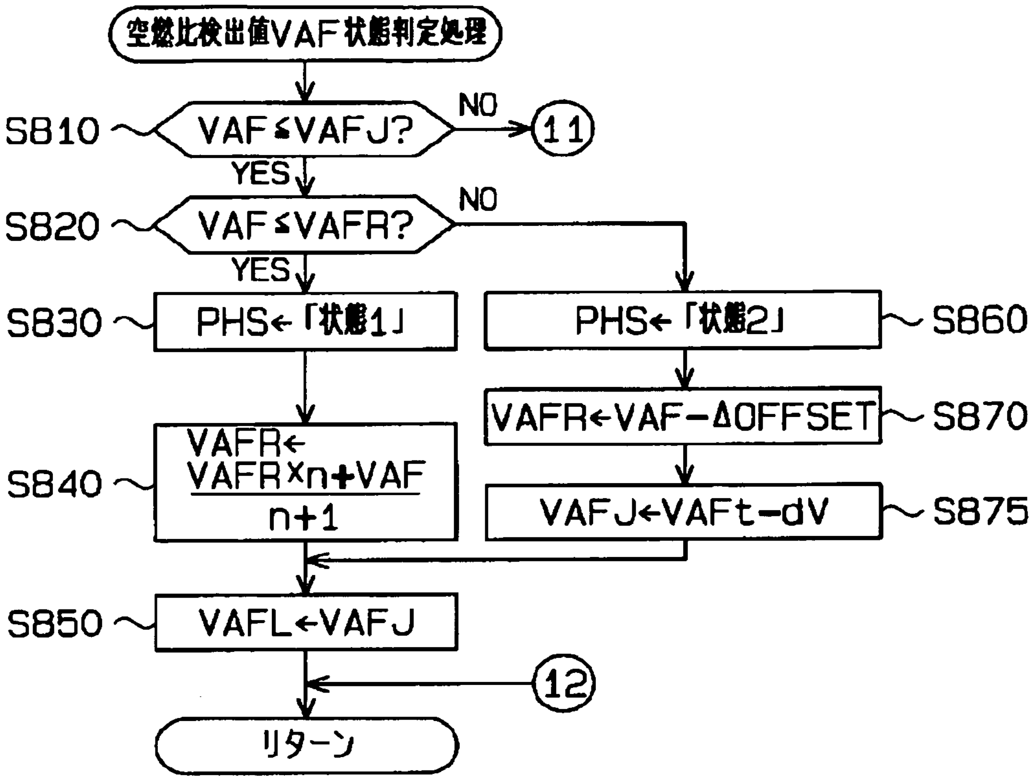
[Drawing 24]



[Drawing 19]

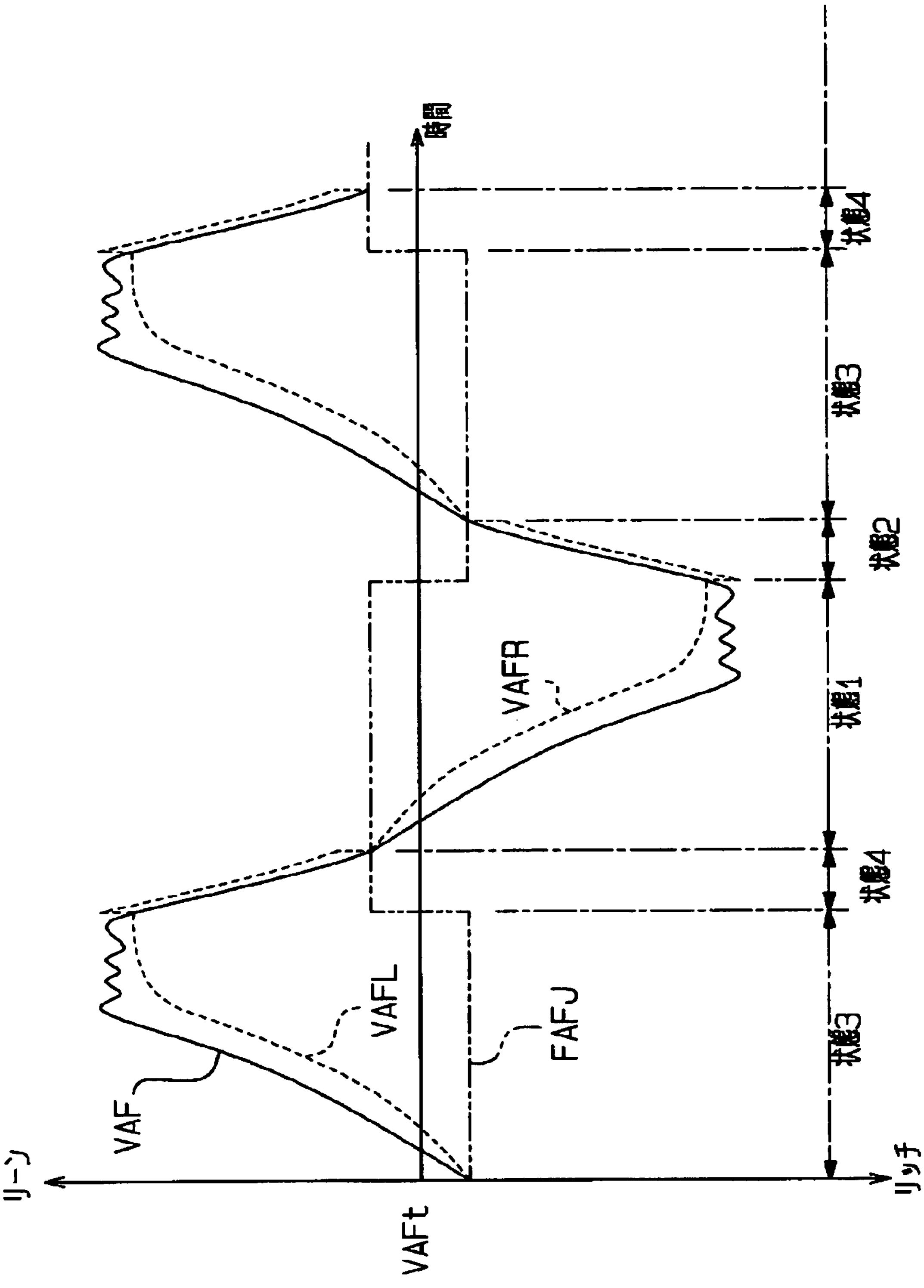


[Drawing 20]



空燃比検出値VAF状態判定処理
S810
VAF≦VAFJ?
NO
11
YES
S820
VAF≦VAFR?
NO
YES
S830
PHS←「状態1」
S860
PHS←「状態2」
S870
VAFR←VAF−ΔOFFSET
S840
VAFR←
VAFR×n+VAF
n+1
S875
VAFJ←VAFt−dV
S850
VAFL←VAFJ
12
リターン

[Drawing 22]



[Translation done.]